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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

Devoted to the Instrument Problems of all Industries

Vol. 1. No. 12 Pittsburgh, Pa. December, 1928

IN THIS ISSUE

Instrument Pioneers—Georg Simon Ohm. (1789-1854)

A Direct-Reading Permeameter.
FRANK P. FAHY, NEW YORK, N. Y.

Measurement of Specific Gravity of Varnishes, Paints, etc.
H. L. HAZELTINE, HAYSVILLE, PA.

New Specifications for Raw Materials.
J. R. TOWNSEND, NEW YORK, N. Y.

New Instruments

New Strength Tester for Knit Goods.
Stainless Pocket Caliper.
New Recording Thermometer for Milk Plants.
The Research Air Flow Indicator.
The Research Fuel Flow Indicator.
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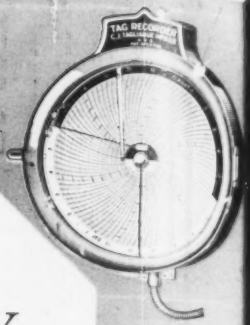

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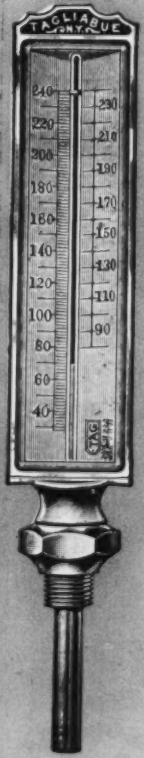

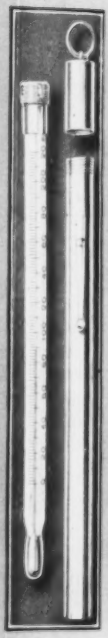

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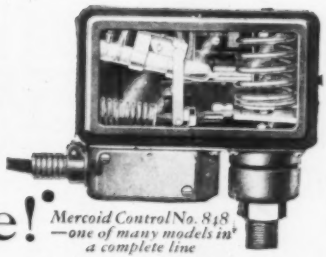

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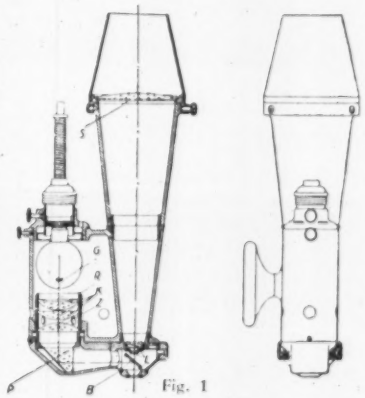
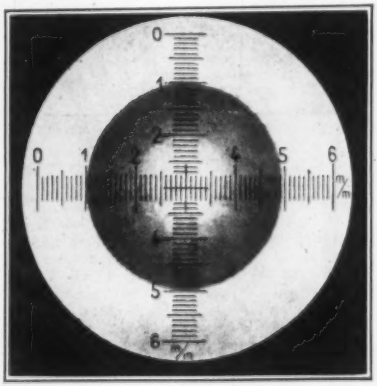


Fig. 1

Measurement of this kind is carried out with extraordinary speed when compared with the former method and is at least of equal accuracy. Fig. 2 shows the ground-glass slide in its natural size up to 2½" diameter, i.e. it is suitable for measuring crater-diameters of ¼ in. or 6 mm.



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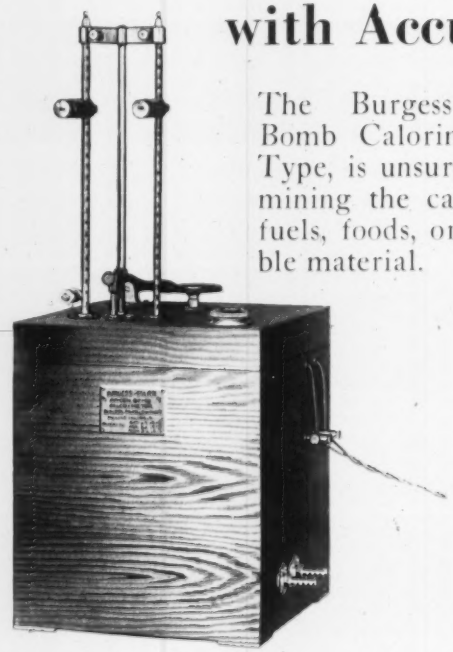

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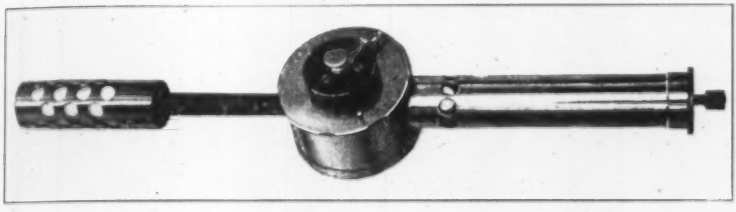

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It will indicate leaks which defy detection when sought with a light.

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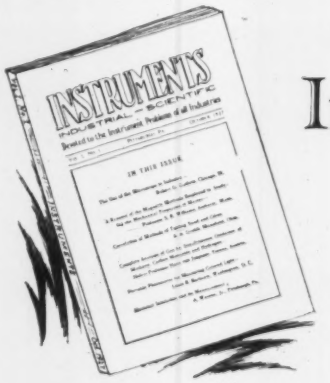

Instruments Service

THE manager of a large southern wall board mill had a control problem. In 15 seconds he wanted to make the following tests: thickness, weight and cross bending strength. He asked the editor of INSTRUMENTS where he could obtain information on instruments and devices to do this.

The engineer in charge of the construction of a large city sewerage disposal plant desired information as to the manufacturers of gauges which would indicate the liquid level in six large tanks, and he asked the editor of INSTRUMENTS for the information.

The research director of a company building boilers desired information on high pressure flow-meters—he asked the editor of INSTRUMENTS.

The chief engineer of a large oil company wanted information on engine indicators—a terra cotta company desired information on hydrometers—a large public utility on steam meters—an electrical engineer on oscillographs—a paper company on a bending tester—a glass company on instruments for measuring roll temperatures—a large automobile axle company on tachometers—a ship building company on engine indicators—a heating engineer on water meters—a machine shop on dial gauges—a celluloid company on machine shop gauges—a combustion engineer on continuous steam colorimeters—etc. All asked the editor of INSTRUMENTS.

Does this not show that INSTRUMENTS is the national publication for all persons interested in instruments and devices for measurement, inspection and control—the logical publication in which to place the advertising of companies who manufacture such products?

Instruments Publishing Company

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When you make an investment, you invariably make it with the sole intention of obtaining some return on your investment, no matter how small the amount may be.

The subscribers of a publication—while their investment may be small—expect to obtain a return on their investment, hence their subscription.

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"Being on the lookout for each issue, I get a little anxious about them when they do not arrive on time."

"Kindly let me know when our subscription expires, as we do not want to miss a single issue."

Do not these expressions show a keen reader interest—are they receiving a return on their investment?

Your sales message in INSTRUMENTS will be a good investment for YOU. Forms for January close January 2nd.

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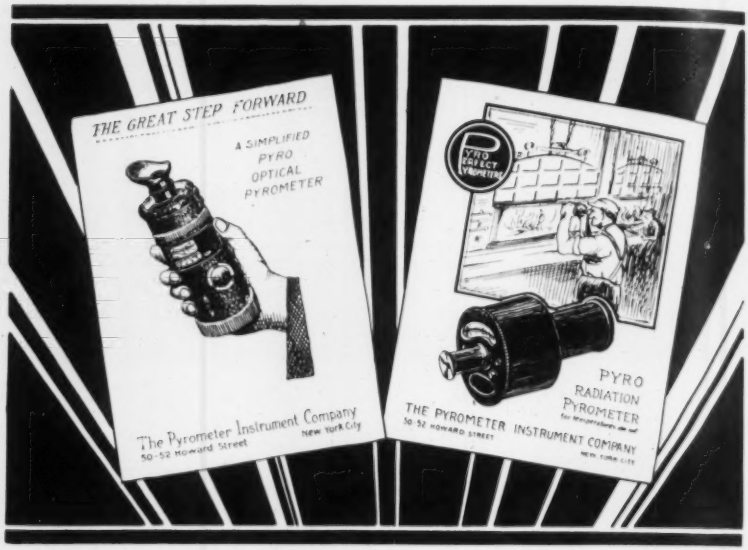

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TABLE OF CONTENTS

	PAGE
Editorial:	
To New Readers	500
The Measurement of Temperature	500
The January Issue of INSTRUMENTS	501
Measurement of Color	501
Measurement of Specific Gravity	502
Correction	502
Instrument Pioneers	503
The Direct-Reading Permeameter—Frank P. Fahy	507
Measurement of Specific Gravity of Varnishes, Paints, etc. —H. L. Hazeltine	515
New Specifications for Raw Materials—J. R. Townsend	519
Information Section	522
New Instruments:	
New Strength Tester for Knit Goods	523
Stainless Pocket Caliper	524
New Recording Thermometer for Milk Plants	525
The Research Air Flow Indicator	527
The Research Fuel Flow Indicator	528
The Research Twin Burette Fuel System	529
New Combustion Meter	531
New Hays Boiler Panel	531
M. J. L. Indicating Flow Meter	533
Steam Flow Meter	535
Catalytic Hydrogenation Apparatus	537

Catalogue Library	539	Buyers' Guide	15
Card Section	11	Advertisers Index	19
Current Literature Review	12	Business Manager's Page	20

Have your stenographer cut out and file the 3 x 5 cards found bound in the back of this issue, listing the principal articles. They will direct you to valuable information to which you may wish to refer in the future.

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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

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Vol 1 No. 12 DECEMBER, 1928 Pittsburgh, Pa.

We wish to thank our readers and advertisers for their confidence and support during this, our first year, and extend to them Our Best Wishes and the Season's Greetings

To New Readers:

INSTRUMENTS was founded in January of this year as a magazine of instruments and devices for measurement, inspection and control. That the need for such a periodical existed is proved by the number and type of subscribers.

A system of distribution was devised so that each name on our mailing list is assured of receiving three copies of the publication, so that prospective subscribers might have an opportunity of appraising its worth to them.

In many cases the sample copies are addressed to the company. These invariably are passed on to the department likely to be interested. The impression may have been gained by some readers that a subscription has been sent in by the company and no further action is necessary.

The next volume will start in January and much interesting and valuable information is in preparation. The January issue will be especially valuable as in addition to the editorial material which will review the instrument developments, many old and new advertisers have signified their intention of presenting their sales message to you. As a consequence the Buyers' Guide will be especially valuable as an intrument index.

In order to assure your receiving INSTRUMENTS regularly in the future, we urge you to ascertain if your company has subscribed, or send us your subscription personally.

———— :: ————

The Measurement of Temperature:

THE editor believes the temperature ranges of instrument applications are important to the users as well as to the instrument manufacturers, and the editor therefore believes that all sides of this question be presented to the readers of INSTRUMENTS—a journal devoted to information on instruments and devices for measurement, inspection and control. We urge our readers to send us their comments on this subject.

In the November issue we had the pleasure of publishing extracts of a letter received from Captain Behar of the C. J. Tagliabue Mfg. Co. Below we print a letter from Mr. S. C. Horn, Sales Manager, Wilson-Maeulen Company, Inc.

"I have noted with considerable interest your publication of extracts of a letter from Captain M. S. Behar on page 467 in the November 1928 issue of INSTRUMENTS.

"Captain Behar seemingly wrote you to point out several instances where he disagrees with some previously published classification of instruments and their proper temperature measuring field, and he included a revision of classification which he believed more complete.

"I would now like to make some improvements on Captain Behar's revision, and I believe my suggestion will be of interest.

"Captain Behar's classification roughly groups all thermometers in Group 1, under the specification 'Below 900° F.' and puts all pyrometers in Group 2, and specifies 'Above 900° F.'

"I would like to suggest that in these days of automatic electric cold junction compensators for millivoltmeters, and instrument temperature compensators for millivoltmeters, and potentiometers with automatic cold junction compensation, it cannot be assumed that 900° F. is the lower limit of either practical or accurate use for instruments employing thermocouples.

"We are regularly employing thermocouples for operating temperatures as low as 400° F. and for heating and cooling temperatures considerably below 400° F., with excellent results both from a standpoint of accuracy and utility, as compared with thermometers, and on multiple installation where a number of thermocouples are used with one indicating instrument, economy is obtained as well.

"The thermocouple type instrument with the accuracy of its modern design presents advantages in long distance reading, central station indication, and ruggedness of the element exposed to the temperature."

::

The January Issue of INSTRUMENTS

THE January issue of INSTRUMENTS will review the developments in a number of instrument fields. The following articles have already been promised:

Developments in the Field of Magnetic Measurements during 1927-1928.—Thomas Spooner.

Electrical Instrument Developments during 1927-1928.—E. S. Lincoln.

Recent Aeronautical Instrument Developments.—Bradley Jones.

Developments in Temperature Indicating,, Recording and Control Instruments during 1928.—D. L. Mathias.

Searching for Instrument Information.

This issue will also contain a very complete Buyers' Guide—in fact this will be a veritable instrument index. A complete list of the periodicals which will be reviewed during 1929, for information on instruments and devices for measurement, inspection and control will also be given.

Also, many new advertisers will transmit information on their products to you.

Renew your subscription NOW so that you will be sure to receive this issue.

::

Measurement of Color

THE editor has pleasure in announcing an important series of articles on Ostwald's Color Theory and the instruments used by him. This series will be written by Dr. Albert Parsons Sachs and the first article will appear in the February issue.

Ostwald's Theory of Color, while receiving widespread recognition in Europe is practically unknown in this country.

This presentation and appraisal of Ostwald's efforts will not only appeal to those specially interested in this subject but to all readers of INSTRUMENTS.

All those who desire to receive each installment of this series, are requested to send in their subscription on the blank in the back of this issue.

Measurement of Specific Gravity

THIS is the second of a series of articles by H. L. Hazeltine, Engineer of Insulation for the Sterling Varnish Company, Haysville (suburb of Pittsburgh), Penna. The next article will deal with the measurement of viscosity.

::

Correction:

AN error occurred in the listing of Mr. John L. Hodgson's name on the cover of the October issue of INSTRUMENTS. This appeared as John M. Hodgson.

::

To help you find any instrument easily and quickly, refer to the Buyers' Guide contained in the back of this book. Turn to it now and see how wide the variety of instruments it offers. Remember to consult the Instruments' Buyers' Guide when in the market for instruments.

::

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Instrument Pioneers

Georg Simon Ohm*
(1789-1854)

GEORG SIMON OHM was born on March 16, 1789 at Erlangen, Germany. His parents were Johann Wolfgang Ohm and Marie Elizabeth Beckin. He was the first of seven children, only three of which grew up; these were Georg Simon, Martin and Elizabeth Barbara. Martin became a distinguished mathematician and a Professor of Mathematics at the Military College, Berlin.

When Georg was but ten years old, his mother died. His father, a locksmith by trade, was a man of exceptional ability. In his wanderings as a locksmith, he had studied philosophy and mathematics. This had brought him into touch with Professor Langsdorf of Heidelberg, who had gone there from Erlangen. Under his father's guidance, the motherless Georg and Martin made progress, and the attention of Langsdof was directed to their aptitude.

For one year Georg attended the Gymnasium of Erlangen and at Easter, 1805, he entered Erlangen University, matriculating in Philosophy on May 3, 1805. His studies were immediately directed to mathematics and physics. Unfortunately, lack of means limited him to but three terms at the University. At the end of September, 1806, through the bookseller Walther, he obtained a post as a mathematical tutor at a school kept by Zehender, a clergyman in Gottstadt, Switzerland. After the third half year at Gottstadt, Georg went to Neuchatel with the object of taking private lessons in mathematics and conversational French. It was at this period that, upon the advice of Professor Langsdorf, he studied the works of Euler and Lacroix. At Easter, 1811, he returned to Erlangen and on October 25th he obtained the degree of Doctor of Philosophy. For three terms he read mathematics, but for reasons of economy he again had to shoulder what to him was the irksome yoke of a teacher.

In November of 1811 he applied to the authorities at Bayreuth, offering his services but was refused. He remained at Erlangen, applying to the King of Bavaria for employment as a teacher. In consequence, on December 16, 1812, Ohm became a tutor at the Realstudienanstalt at

*Abridged by permission from "Electrical Communication."

Bamberg. He wrote repeatedly to the King and the authorities but without success.

The year 1813 was critical in the history of Europe, it brought Germany to the storm-center of the struggle against Napoleon. Georg was then 24, of military age, but either upon the grounds of philosophy, physical unfitness, or natural reluctance, he stood aside from military service.

In the spring of 1817, he published his first book. He dedicated it to the memory of his father and gave it the impressive title, "Grundlinien zu einer zweckmaessigen Behandlung der Geometrie als hoeheren Bildungsmittel an vorbereitenden Lehranstalten," and he sent a copy to the King of Bavaria, beseeching him to grant amelioration of circumstances. The royal reply stated: there was no appointment vacant, but the book had been placed in the library.

Copies of the book were sent to other monarchs and amongst them, fortunately to Friedrich Wilhelm III of Prussia, who looked with favor upon the application. Ohm left Bavaria in the Autumn of 1817 and became Oberlehrer in Mathematics and Physics at the Royal Konsistorium in Cologne. There he found friends and apparatus, a library, and greater freedom. The physical apparatus at the Jesuit Gymnasium of Cologne enabled him to proceed with the investigation of the galvanic circuit. He investigated the relative conductivities of metals, the theory of the galvanometer, and by experiment, the law of flow of electricity in conductors. In 1826 he was granted a year's leave of absence and he betook himself to his brother's house at Berlin. The tangible result of his sojourn in Berlin was his book, "Die galvanische Kette, mathematish bearbeitet," which was published in Berlin in May, 1827.

Confirmation of his law of electrical circuits described in this treatise, came from Fechner of Leipzig, from Pfaff of Erlangen, and from Poggendorf of Berlin. Criticism, however, was levelled against it, gently enough by Kaentz of Halle, but more provokingly by G. F. Pohl in the Jahrbuecher fuer wissenschaftliche Kritik, to which Ohm forcibly replied. Scientific strife led to the breaking off of friendly scientific relations, and Ohm, taking into account the true nature of the opposition, relinquished his appointment at Cologne, and during the six years, 1827-1833, retired into private life.

Apart from these initial skirmishes, Ohm's law was for some years scarcely noticed, except by a few physicists. Ohm's triumph came in 1841, when the Council of the Royal Society of London awarded him the Copley Medal for his researches into the laws of electric currents. They declared that Ohm had established for the first time, the laws of the electric circuit. To Ohm the Council also assigned credit for providing means to determine with accuracy the value of the separate resistance and electro-motive forces in a circuit.

From 1827-1833 he gave mathematical instruction at the Military School at Berlin. He tried unsuccessfully to obtain a better appointment there or at Oldenburg; for the remuneration was less than half what he had received at Cologne. On July 3, 1833, King Ludwig I, of Bavaria, issued a decree that relieved Ohm of these anxieties. He was given a professorship at the Polytechnic School of Nuremberg, and he retained touch with that institution until 1849. In 1835 he was appointed also to the Chair of Higher Mathematics at the University of Erlangen, and at the same time State Inspector of Scientific Education. Towards the end of 1849 he was appointed by Maximilian II, Professor of Physics to the University at Munich; the Akademie of Science selected him as Conservator in Mathematical Physics and in addition he was advisor concerning the development of telegraphy for the state.

The work of Ohm upon so-called "unipolar" substances deserves attention. It relates to experiments by Jaeger, Becquerel, Fechner, Ermann, and others, with metallic plates and condensers, particularly with regard to the effect of earth connections and residual charges, and to a group of partial conductors, containing disturbing electromotive forces. Ohm realized that much of the trouble, causing differences of opinion, arose from defective instruments, especially the galvanometer as then constructed. Thereupon he directed attention to the merits of the electrometer that deals with only single points of a circuit, and he advocated the simultaneous use of both instruments.

At 10 P. M. on July 6, 1854, on which day, notwithstanding his bodily weakness, he had delivered his lecture, Ohm died.

Note: In 1881, The Electrical Congress at Paris adopted the name of Ohm for the practical unit of electrical resistance.

Information in Instruments

A GREAT number of our readers have expressed their approval of our efforts to cover the developments in the field of instruments both in this country and abroad. The editor takes this opportunity to assure these and all other readers, that he will continue to cover by the original articles, new instrument section and current literature review, all information on instruments the world over. A number of very interesting papers have been promised for future issues. NO ONE, WHO IS CONCERNED WITH INSTRUMENTS CAN AFFORD TO MISS A SINGLE COPY

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A Direct-Reading Permeameter

*Frank P. Fahy**

THE need of reliable information as to the magnetic characteristics of materials is well appreciated in the electrical field. It is a truism that electrical engineering is largely a matter of magnetic engineering since, with few important exceptions, the generation of electricity and the apparatus associated with its economic utilization involve the use of magnetic materials. Interest in magnetic testing has been greatly stimulated by the remarkable developments of the past few years along the line of new materials. But quite aside from the value of magnetic data in the electrical field, there are other aspects of constantly growing import. For example, many metallurgists and chemists are concerned with the magnetic characteristics of ferrous materials, not only because of the important light these are capable of throwing upon the constitution and the general physical properties, but as a means of readily identifying departures from a recognized standard.

A rough comparison of the magnetic properties of different specimens is relatively simple to make, but to have real value as immediate or later criteria the test data should be in, or capable of reduction to, absolute units. The development of modern precision permeameters has made possible the obtaining of data of very high accuracy, but the apparatus essential thereto is rather complicated and expensive and the design always involves the measurement of purely transient impulses, thereby calling for a more or less delicate galvanometer. The use of such equipment is warranted, and in fact necessary, in first-order research or where quite rigid commercial specifications are to be met and the one apparatus must handle a wide range of test sections.

It has long been recognized that sacrifice of a limited degree of accuracy and a restriction as to the section of the test specimen are justified if such concessions would permit of evolving a practical and rugged permeameter, without complications in accessory equipment and allowing of quick test determinations. The first step toward this end is the finding of some simple, satisfactory system of the static deflection type to replace the galvanometer; the next is to so design the magnetic circuit and the magnetomotive force elements associated therewith as to allow of an accuracy sufficiently high for practical requirements. There would result a direct-reading instrument by means of which the values of, and the relation between, the magnetizing force (H) acting upon a specimen and the induction (B) in the specimen could be determined under a quite ideal procedure.

The development of such a direct-reading permeameter was attempted some years ago, but was found frought with many difficulties and com-

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plications. The earliest endeavor, and the most successful, was due to Koepsel[1], the device being later improved by Kath[2], and for quite some time knew wide use as the Koepsel permeameter. In principle, the apparatus consists of a moving coil, direct current measuring instrument of the d'Arsonval deflecting pointer type in which the usual permanent magnet is replaced by an electromagnet, one portion of which latter consists of the specimen under test. The design of the Koepsel permeameter provides for two current circuits, these being supplied with direct current from independent battery sources. Observation of the magnetomotive force acting upon the magnetic circuit is made in terms of the current flowing through a solenoidal winding encircling the test specimen; the resultant induction is read directly from the deflection of the moving coil system by means of a pointer attached thereto which moves over a calibrated scale. This moving coil carries a current which has been adjusted in value in accordance with the section of the specimen. Obviously, a part of the whole applied magnetomotive force is absorbed in overcoming that portion of the reluctance of the magnetic circuit which lies outside of the specimen itself. This outside reluctance is that due to the electromagnet yoke, the moving coil air gap and the contact joints. These necessitate corrections to the observed magnetomotive force, in the form of subtractions, to obtain the true magnetizing forces acting upon the test specimen.

The Koepsel permeameter has been the subject of an extended investigation at the U. S. Bureau of Standards[3] and has been found to give results which are variable not only with the nature of the specimen under examination but with the particular value of induction. To a large extent the inaccuracy of the Koepsel permeameter arises from the use of a method of automatic yoke compensation which is dependent upon the value of the magnetizing current. This is an important feature of the instrument but one which renders indeterminate the nature of the corrections to be applied and leads to great inaccuracy in the determination of hysteresis. The corrections should be a close function of the magnetic flux and that alone. As this does not obtain, it is necessary to furnish with the Koepsel permeameter a number of graphs or "shearing curves" corresponding to the normal induction and hysteresis characteristics of various qualities of test material, from which such corrections may be scaled off. Since it is impracticable to cover thus the whole range of possible test specimens, unsatisfactory interpolation must be resorted to. While this permeameter is designed to permit the testing of a fairly wide range in test specimen section, the limitations observed hold for any one section. The recommended section is about 0.25 cm², which is too small for many practical requirements. The Koepsel permeameter, however, represents a very important step for-

1. A. Koepsel: E T Z., 15, p. 214; 1894
2. H. Kath: E T Z., 19, pp. 411-415; 1898
3. Bulletin of the Bureau of Standards, Vol. II, 1914; pp. 101-130.

ward and it will be necessary to refer to it again later in explaining the modifications which have been found necessary to produce an efficient instrument.

The new development to be described results from an investigation on the part of the writer which has extended over the past few years, during which a number of experimental types of permeameters were constructed and studied. It has been found possible to produce a highly satisfactory apparatus by invoking several new principles in design, one of which concerns the use of the same highly accurate magnetic potential system of measurement which has been so successfully employed in the Simplex permeameter[4] for the past eleven years. In the direct-reading permeameter, however, the magnetic potential is used as a basis of measure of induction while in the Simplex permeameter it is utilized for the purpose of measuring magnetizing force. Compensation to take care of the varying relative reluctance of test specimens and yoke is effected by a magnetizing winding design which allows the test specimen itself to bring about such compensation. By these means the difficulties and limitations inherent to former designs have largely been overcome, allowing of an accuracy in measurement which is independent of the quality and nature of the test specimen to an extent hitherto deemed out of the question.

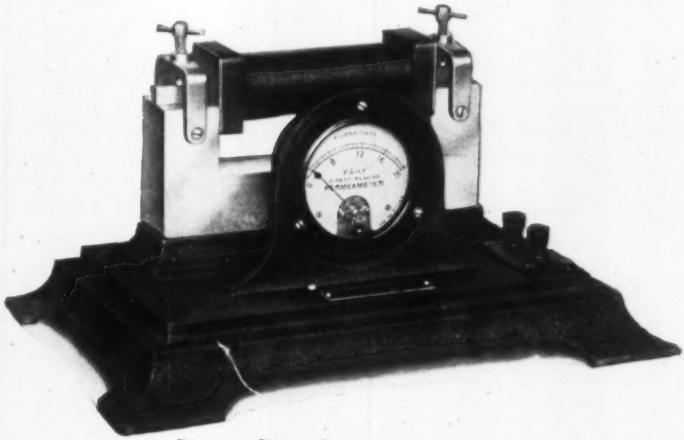

Fig. 1—Direct-Reading Permeameter.

The new permeameter is illustrated in Fig. 1. A U-shaped yoke of laminated material is provided which is vertically mounted upon a cast aluminum base. The upper faces of the yoke legs act as contact surfaces for the material under test, the specimen being passed through a magnetizing winding which spans the legs. The laminations of the yoke are so grouped that their width is normal to the length of the specimen,

4. Circular No. 17 Magnetic Testing. Bureau of Standards, 1926.

so as to insure proper flux distribution across the yoke section. Clamps are provided to promote good contact. Centrally located in the lower portion of the yoke is an air gap and mounted across this air gap is a meter of the moving iron, repulsion type, which is constructed to function as a fluxmeter. This fluxmeter is supplied with a scale calibrated to indicate directly the flux in the test specimen which results from any magnetomotive force applied through the magnetizing winding. Binding posts mounted upon the base allow for the external connections. Broadly speaking, the instrument follows the general idea of the Koepsel design but with new features which combine to explain its exceptional performance. The most important of these have to do with the construction and action of the fluxmeter and the form of the magnetizing winding.

The purpose of the fluxmeter is to provide for direct reading of the flux in the test specimen. In the usual design of a meter of the repulsion type as employed for current or voltage measurements, there is provided an interior exciting winding which surrounds the repulsion elements and causes them to repel each other in accordance with the value of the current flowing in such winding. In the construction of the fluxmeter used with the direct-reading permeameter there are provided, in place of such winding, two specially shaped iron shoes which have contact outside of the fluxmeter case with the permeameter yoke, at either side of the yoke gap. Within the case these shoes are so arranged about the iron elements that any flux diverted from passage across the yoke gap acts upon these elements in the same manner as would result from flux due to an exciting winding. Since the local magnetic circuit formed by the contact shoes and the iron elements of the flux meter, in shunt to the yoke magnetic circuit, is one of relatively high reluctance due to the large gaps therein, the flux in this circuit is related to the magnetic potential acting across the yoke gap. Since in turn the potential drop across the yoke gap is in direct proportion to the flux in such gap, it follows that the fluxmeter may be calibrated to indicate directly this flux. The contact shoes and the iron elements of the fluxmeter are constructed of material which is practically devoid of hysteresis effects. The use of an indicating instrument having such characteristics avoids the difficulties and complications inherent to the d'Arsonval type as employed in the Koepsel permeameter. This not only has pronounced hysteresis characteristics but in addition calls for an auxiliary current circuit with external battery supply, rheostat and ammeter, all of which are thus avoided.

The design of the magnetizing winding for the new permeameter represents a marked departure from that hitherto used in any type of permeameter. This winding does not cover the full free length of the test specimen between the yoke legs, but is distinctly shorter. This is to insure that no matter what the characteristics of the specimen, the

ratio of the magnetomotive force acting upon it and that acting upon the yoke shall be a function of the flux in the specimen and that alone. In other words, the effect is that the specimen itself provides a compensation which is in direct proportion to its own reluctance. From this follows two outstanding advantages: 1. the flux indicated by the fluxmeter gives directly the induction in a test specimen of standard section; 2. the effective magnetizing force acting on the specimen can always be computed from the value of the apparent magnetizing force and the fluxmeter reading. This permits the use of correction factors which may be concisely stated.

The permeameter as illustrated is designed for the testing of specimens 7½" in length and of rectangular section ⅜" x ⅜", (0.907 cm²), the fluxmeter being calibrated to read directly from 0 to 20000 gausses for such standard section. The opening in the magnetizing coil is oversize and it is not necessary to rigidly adhere to the standard section, as variations 10% or more above or below are feasible, due allowance for

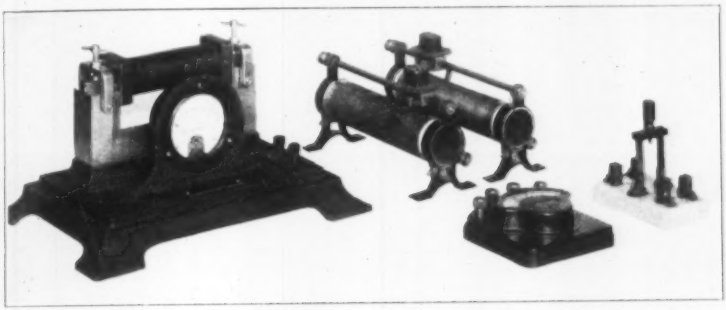

Fig. 2—Permeameter and Control Apparatus.

such change from the standard section being made in interpreting the fluxmeter readings, as shown below. A rectangular section has been selected as preferable, as its use insures better contact with the pole faces and avoids contact bushings. The instrument is also adapted to the use of a special magnetizing winding to receive strips of laminated material of the standard 1 3/16" (3 cm.) width, in which case bushings of angular form are used to allow of proper edge contact.

In Fig. 2 is shown the permeameter together with the control equipment required for carrying out tests. This comprises two small rheostats, an ammeter (preferably having three ranges) and a double-pole, double-throw switch arranged as a reversing switch. A 6 to 12 volt storage battery (not shown) is required as a source of direct current supply. The magnetizing winding is designed so that the applied magnetomotive force per unit length of specimen is equal to 50xI, where I is the magnetizing current in amperes. A maximum magnetizing current of five (5) amperes is amply sufficient for all testing.

This permeameter can be used for the determination of normal induction (permeability) under magnetizing forces up to 200, or a limiting standard induction of 20000, and also in the determination of hysteresis characteristics. A normal induction curve, OAC in Fig. 3, is the curve obtained by plotting the values of induction, B, which are reached under the action of various magnetizing forces, H, the test material having been demagnetized as a preliminary. The quantity, B/H, gives the permeability at the corresponding induction. The curve CDEC′ represents the values of induction which are successively passed through when the maximum magnetizing force corresponding to an induction represented by the point C is changed from a positive to an equal negative value. The curve CD′E′C represents the further change in induction as the maximum magnetizing force again becomes positive. OD and OE (or OD′ and OE′) represent the residual induction and coercive force, respectively.

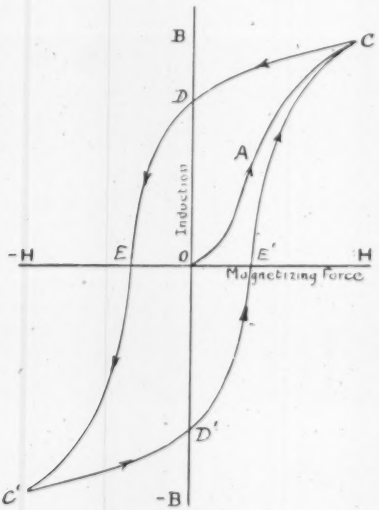

Fig. 3—Normal Induction and Hysteresis.

In the obtaining of the data represented by the curves of Fig. 3 there are two test observations to be made. One is the apparent magnetizing force F, which is equal to 50 x I, where I is the magnetizing current in amperes; the other is the indication of the fluxmeter in kilogausses, which we shall call B_{obs}. Then:

for normal induction: $H = F - a\ B_{obs.}$

for hysteresis: $H = F - b\ B_{obs.}$

where H is the actual magnetizing force operative on the test specimen, a and b are predetermined constants of the permeameter. It will be clear that the quantities to be subtracted from F represent the portion of the applied magnetizing force which is absorbed in overcoming

the reluctance of the magnetic circuit outside of the test specimen itself. Now, if the test specimen is of the standard section, s, (.907 cm^2) then B_{obs} is B, the true induction. If the test specimen has a section s', then the true induction is $s B_{obs}/s'$. Thus the values of the actual magnetizing force and the induction are directly obtained. In the comparison of many samples very nearly alike, it is often not necessary to plot the curves of Fig. 3 or to apply corrections to the observed magnetizing force in order to draw satisfactory conclusions. Furthermore, when testing material of very high reluctance the corrections are frequently very small from a percentage standpoint and may be ignored.

(In the foregoing, the new permeameter has been discussed solely upon the basis of its use in direct current testing for the purpose of determining permeability and the hysteresis characteristics. It is of interest to note, however, that the same type of instrument offer great possibilities for use in alternating current testing, particularly in the comparison of materials. That is, not only does the fluxmeter described function satisfactorily in the measurement of an alternating flux, but the yoke and magnetizing winding details are such as to permit of the application of alternating magnetomotive forces without appreciable eddy current effects.)

This direct-reading permeameter is the result of an attempt to provide a comprehensive, simple and reliable testing means which will allow of the use of a test section sufficiently large to be representative of its kind of material and one which is free of many of the complications and limitations hitherto found in permeameters. In its design, the often expressed needs of the electrical manufacturer, the metallurgist and of technical and other educational institutions has been kept in mind. The accuracy attained is more than ample to meet the majority of practical requirements and excels that of a number of permeameters which have been classed as precision instruments.

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THE MICROSCOPE. A SIMPLE HANDBOOK. *Conrad Beck.* R. & J. Beck, Ltd., 1923. Cloth, 144 pages. $1.25 postpaid.

THE MICROSCOPE. AN ADVANCED HANDBOOK. *Conrad Beck.* R. & J. Beck, Ltd., 1924. Cloth, 231 pages. $2.50 postpaid.

THE MODERN CALORIMETER. *Walter P. White.* Chemical Catalogue Company, New York, N. Y., 1928. Cloth, 194 pages, $4.00.
Review by Arthur Schroder on page 9 of the July issue of INSTRUMENTS.

HISTORY OF RADIO TELEGRAPHY AND TELEPHONY. *G. G. Blake.* Chapman & Hall, Ltd., 1928. 6x9 Cloth, 425 pp., 197 figs. $7.50 postpaid.
Review by M. Hartenheim on page 20 of the November issue of INSTRUMENTS.

DIE TECHNIK ELEKTRISCHER MESSGERAETE. *George Keinath.* R. Oldenbourg, Germany, 1928, 3rd completely revised edition.

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Measurement of Specific Gravity of Varnishes, Paints, etc.

*H. L. Hazeltine, Haysville, Pa.**

LIKE twins specific gravity and viscosity generally appear together when varnishes, paints, etc., are under consideration. Although related and more or less dependent upon each other, like twins, each has its own individual characteristics and one should not be confused with the other.

Specific gravity deals with the weight of a substance, while viscosity refers to the flowing characteristics of a fluid.

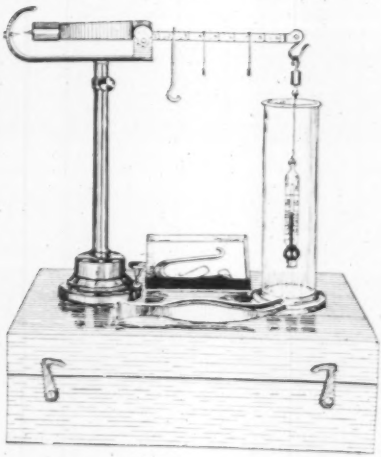


Fig. 1

"This varnish has no body," is an expression often heard. It may mean that the varnish is light in weight or it may mean that it flows easily to a thin film, depending upon the interpretation given by the observer.

Specific gravity is defined as the ratio of the weight per unit volume of a substance to the weight per unit volume of a standard material. In the case of gases, hydrogen or oxygen is the standard. In the case of solids or liquids, distilled water is the standard.

Since the volume of all substances varies with the temperature, the weight per unit volume of the substance must be determined at the same temperature as the weight per unit volume of the standard material. Any temperature convenient for the experimenter may be chosen, but thereafter all specific gravity measurements should be made at that temperature or corrections made for variations. For scientific work the temperature of water at its maximum density (4°C.) has been selected.

Obviously the specific gravity of a standard material, regardless of the temperature, is 1.000; also obviously since some substances are heavier than standard and some lighter, their specific gravity will be either greater or less than 1.00.

Fig. 2

The determination of the specific gravity of the solids is comparatively easy. The most common method being to divide the weight in air by the difference between the weight

*Engineer of Insulation, Sterling Varnish Company.

in air and the weight in distilled water and then divide this result by the weight per unit volume of distilled water.

The determination of specific gravity of liquids (paints and varnishes fall in this category) requires more special apparatus. The Westphal balance (Fig. 1), pycnometer (Fig. 2), or the hydrometer are the instruments most commonly used. Of these the hydrometer is the most usual in paint and varnish work.

Since varnishes are generally lighter than water, an hydrometer designed for measuring specific gravities of liquids lighter than water should be chosen.

The instrument consists of a glass tube with graduated stem of uniform diameter, a bulb to cause it to float in the liquid and a weight at the bottom to hold the stem erect. It may be calibrated to read specific gravity in decimals or in some arbitrary scale, such as Baumé. Figure 3 shows an hydrometer suitable for this work together with table showing comparisons between specific gravity and the Baumé scale.

The surface of the liquid under test is first freed from all air bubbles. The hydromometer is then held in a vertical position and lowered carefully into the liquid so as not to disturb the equilibrium. When all movement has ceased after removal of the hand the specific gravity is read as the point on the scale which coincides with the liquid surface, an allowance being made for the meniscus.

Like most other liquids, varnishes expand as their temperature is raised and contract as it is lowered; therefore specific gravity should always be measured at the same temperature or an allowance made for the difference in temperature. The most convenient temperature for measuring is that most general in work rooms, 21°C. (70°F.). The correction to be applied is plus .0007 per degree C if the temperature is below 21°C. and minus .0007 per degree C. if the temperature is above 21°C.

To understand the value of the test for specific gravity, one must consider varnishes as being made up of two component parts; the base—or useful material—and the solvent. Since the specific gravity of the base of all varnishes is practically the same, it is obvious that any variation in specific gravity of the finished material will be due to variations in the percentage of base or in the specific gravity of the solvent. Since no two varnish companies use exactly the same grades of solvent and since the solvent used by any one company in two or more varnishes may differ considerably, specific gravity should not be used as a means for establishing the comparative merits of two given materials. Its value lies in the fact that for a given material the solvent should be always the same and hence a constant specific gravity will indicate a constant percentage of base and therefore a uniform product. This is of vital importance to the user, since the base or useful material is the portion

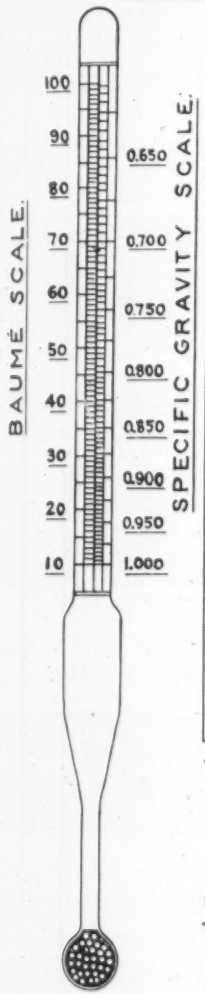
that gives him the protection desired, the solvent being merely a vehicle which serves to carry the base over the surface and once this function has been performed it disappears into the air.

The test, therefore, serves as an excellent control test. The specific gravity of any given varnish should not vary more than plus or minus .002 between any two shipments.

Specific gravity, if properly understood, becomes of value to the re-

COMPARISON OF BAUME AND SPECIFIC GRAVITY SCALES.

For Liquids Lighter than Water at 15° C. (60° F.).



Baumé	Specific Gravity	Baumé	Specific Gravity	Baumé	Specific Gravity
80	0.667	56	0.753	32	0.864
79	0.670	55	0.757	31	0.870
78	0.673	54	0.761	30	0.875
77	0.676	53	0.765	29	0.881
76	0.680	52	0.769	28	0.886
75	0.683	51	0.774	27	0.892
74	0.686	50	0.778	26	0.897
73	0.690	49	0.782	25	0.903
72	0.693	48	0.787	24	0.909
71	0.697	47	0.791	23	0.915
70	0.700	46	0.796	22	0.921
69	0.704	45	0.800	21	0.927
68	0.707	44	0.805	20	0.933
67	0.711	43	0.809	19	0.940
66	0.714	42	0.814	18	0.946
65	0.718	41	0.819	17	0.952
64	0.722	40	0.824	16	0.959
63	0.725	39	0.828	15	0.966
62	0.729	38	0.833	14	0.972
61	0.733	37	0.838	13	0.979
60	0.737	36	0.843	12	0.986
59	0.741	35	0.849	11	0.993
58	0.745	34	0.854	10	1.000
57	0.749	33	0.859		

To convert degrees Baumé to Specific Gravity:

$$\text{Sp. Gr.} = \frac{140}{130 + {}^\circ\text{B}}$$

To convert Specific Gravity to degrees Baumé:

$${}^\circ\text{B} = \frac{140}{\text{Sp. Gr.}} - 130$$

Above scales are at the standard reference temperature 15° C. (60° F.), on which commercial ratings are based.

To find specific gravity at other temperatures;
Add 1° B. for every 5° C. (9° F.) below 15° C. (60° F.)
Subtract 1° B. for every 5° C. (9° F.) above 15° C. (60° F.).

Fig. 3.

ceiving clerk in checking the contents of shipments. There is no accurate method of easily determining the contents of a barrel of liquid unless specific gravity is known. With the Sterling Varnish Company the receiver need only check gross, tare and net weights. By multiplying the specific gravity by 8.335, the number of pounds per gallon can be obtained. The net weight divided by this result gives the number of gallons in the barrel: i.e.:

$$\text{Gallonage} = \frac{\text{net weight}}{\text{Specific gravity} \times 8.335}$$

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Integration of "Orifice Head" Charts by Means of Special Planimeters.
Dilatometry.
Temperature Control in Process Industries.
Correct Connections for Polyphase Watt Meters.
Modern Precision Measuring Tools for Machine Shop Use
Why Flyers Need Instruments.
Organization in Research.
Weighing Devices.
Conservation through Metering.
The Measurement of Illumination.
Flow Measurement.
Blind Flying Instruments.
Automatic Combustion Control.
Optical Pyrometry.
The Importance of Measurements in the Power Plant
Equipment Used in Aerial Surveying.
Automatic Control of High Temperatures.
Instruments for Geodetic Prospecting.
The Measurement of Pressure.
Speed Recording Instruments
New Inventions Needed.
Instruments applied to the Open Hearth for Efficiency
Mechanical Vibrations and Their Measurement.
Instruments to improve Diesel Engine Efficiency.
Comparison of Instruments for Measuring Hardness.

New Specifications for Raw Materials

*By J. R. Townsend**

STUDIES of the properties of materials have been made in the past, but with the increasing complexity of the telephone plant these studies have had to be carried forward to greater detail in order to set up more precise standards of quality. Furthermore, the growth of the Bell System requires vast quantities of materials, and much depends upon the steady flow of materials of the proper quality and uniformity into the manufacturing plants.

The raw materials used in telephone apparatus are controlled by specifications which depend upon the basic physical qualities of the material and the requirements of manufacture. Within the last few years a new series of specifications has been inaugurated by the Laboratories to cover those raw-material requirements that are of engineering concern. More than a score of these specifications have been issued; they cover such diverse materials as wax, duralumin, powdered permalloy, silk, cable sheath, lubricating oil, and sheet brass. It is intended that all the important materials used in telephone apparatus shall be covered ultimately by specifications. They serve to collect, and state precisely, all the engineering information necessary to secure material of the proper quality. The Western Electric Company uses this engineering information in the preparation of purchase specifications.

In preparing the specifications considerable care is taken to see that the quality of the material is correct from an engineering standpoint. Economic considerations such as sources of supply and commercial grades are also considered. The requirements are submitted to the Western Electric Company in order that questions of mutual interest in the production of telephone apparatus may be considered, and that the requirements after study from a commercial viewpoint will be entirely acceptable to all concerned. In important cases a joint study is made of raw materials covering the manufacturing history and physical properties as a basis for specification work.

A striking instance of such an investigation is that made by the Western Electric Company, the Northern Electric Company, the American Brass Company and the Laboratories which led up to the new specifications for non-ferrous sheet metals. These materials—brass, phosphor bronze, nickel silver, and the like—are widely used in all sorts of apparatus. They must be capable of fabrication in various ways to produce apparatus parts having resistance to wear, bending, torsion, vibration, corrosion, and so forth. Some of the essential physical prop-

*Apparatus Development Department, Bell Telephone Laboratories.

erties desired—ductility, tensile and compression strengths, hardness, elastic and endurance limits—can be measured with great accuracy. Some can be correlated with others, as for example endurance limit with tensile strength and again hardness with tensile strength. A complete tensile test will give many of the essential mechanical properties of sheet metals. However, for the inspection of raw materials, this test leaves much to be desired; a piece has to be cut from the stock, milled to size, and destroyed by the test itself. The test for hardness can be made on the raw stock, and is not destructive. If then a satisfactory test of hardness could be found, and correlated with the results of tensile tests, much time and expense would be saved.

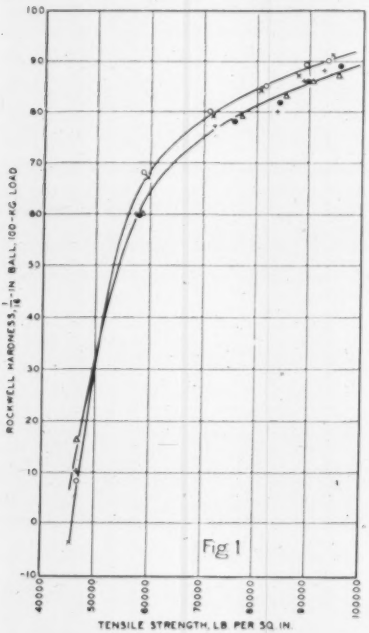


Fig. 1

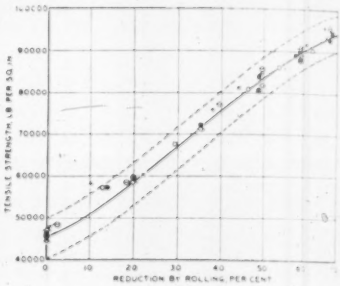


Fig. 2

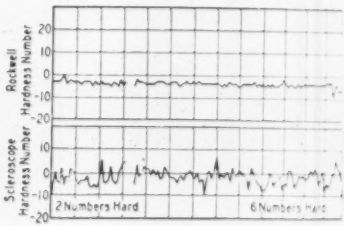


Fig. 3

One measure of the desirability of a testing method is its reproducibility—that is, whether or not it can be depended upon when applied by different observers using different instruments. This point is particularly important in inspection testing, where the work is done in separate places.

The method of attack on the problem of non-ferrous metals was to have the Brass Company prepare sample lots of sheet metal, as, for example, sheet brass, rolled to various thicknesses and hardnesses. The rolling was done in a commercial manner, but very careful data were obtained of the actual conditions surrounding the manufacture of the metal. Complete physical tests were made in the Laboratories upon

these samples, and the data were sent to all collaborators. These tests confirmed what had long been felt, that the scleroscope test of hardness as formerly specified did not give sufficiently precise results when used under inspection conditions. This test has therefore been eliminated from our specifications. A close agreement however was found between the Rockwell hardness numbers and tensile strength. This is evident from the uniformity with which the points of Figure 1 lie along one or other of the smooth curves. Furthermore, Rockwell hardness numbers as determined on five different instruments showed that the various inspection results of producer and consumer could be expected to agree.

With the data from the laboratory tests and from previous work and from experience with actual shipments of material, requirements were drawn up for non-ferrous sheet metals. It was determined that at the present time the best means of specifying the quality of these metals is the tensile test. In the new specifications this is given as the basic test and the Rockwell hardness test is used for inspection since it is non-destructive and easy to apply. In case of doubt as to whether the material fulfills the requirements, a tensile test is made. The Rockwell test is specified for all thicknesses of sheet brass down to 0.020 inch. For thinner material, a tensile test is always made since the Rockwell test is unsatisfactory here.

As part of its responsibility in the design of apparatus, the Laboratories select appropriate raw materials, whose quality they define in terms of precise test. This care, exemplified in the specifications for non-ferrous sheet metals, is one of the Laboratories' contributions to uninterrupted telephone service.

It is common experience that next to possessing information the ideal consideration is to know where to find it. This is especially true at present when the vast amount of information probably available on almost any subject is so great as to lie beyond the capacity of an individual. The problem usually is to know where to find what is wanted.

The world-wide demand for information of all kinds has grown so rapidly that one is often at his wit's end to know where to look for it.

If you are looking for instrument information—you will find it in Instruments.

Back Issues Not Available

REQUESTS are received daily for back issues of INSTRUMENTS and we are sorry that it is not possible for us to comply with these requests.

In answer to our appeals for the return of copies of this issue we have to-date received so few copies that there are still over three hundred requests we cannot fill.

Information Section

Correspondence from instrument users and others pertaining to or relative to instruments

THIS section invites correspondence from instrument users and others relative to questions pertaining to instruments.

Names and addresses of manufacturers of instruments will be furnished on special request. Inquiries pertaining to sources of supply should be addressed in writing to our Information Section. Such inquiries will be answered promptly by mail.

Inquiries regarding instrument problems will be answered by publication in this special "Information Section" of INSTRUMENTS. We feel that other besides the inquirers may be interested in the same or similar problems, and in this way all of our readers will obtain the benefit of the information furnished.

No. 2. Can you put us into communication with the manufacturers of the Howard-Dolman Depth Measurement Instrument?—E. F. H.

No. 37. In the manufacture of our product, it is necessary to make all the seams of the container absolutely vacuum tight. At the present time, as the product is assembled, we test it for minute leaks by immersing in a tank of warm water and applying compressed air at 60 lbs. pressure to the interior of the product. Tests for leaks by this method is a slow and expensive process and in addition, the very minute leaks which would give off a bubble the size of a pin point every minute or two, is not always observed, resulting in extra labor at the point where the product is exhausted for vacuum. If it would be possible to produce an instrument or an apparatus which would definitely and quickly determine that each container leaked or did not leak, it would be of considerable value to us.—H. M. B.

No. 38. Can you send us the names of manufacturers of .0005 inch diameter carbon wire?—V. P. C.

To the Instrument Companies

IN order to keep the readers of INSTRUMENTS in touch with the latest developments in industrial and scientific instruments, the editor again urges all manufacturers of such instruments to keep him informed of all new instruments or important improvements made by them as soon as they appear, by letting him have deescriptions of about 1000 words including construction, peerformance, and applications.

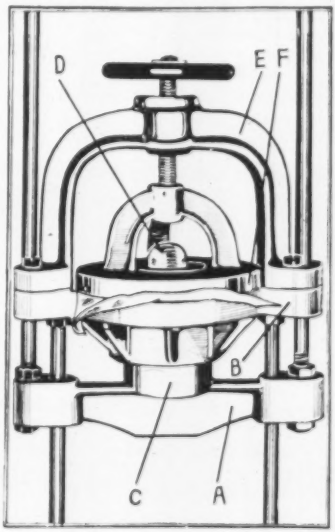
New Instruments

Recently Developed by Instrument Manufacturers

New Strength Tester for Knit Goods

A NEW attachment to test burst strength of knit goods by the ball and ring method has recently been placed on the market by the Henry L. Scott Company.

Heretofore, manufacturers of knit goods had perforce to depend for strength tests on machines employing rubber diaphragms and the standards arrived at showed a marked divergence of opinion, due in no small part to the eccentricities of the rubber diaphragms. The figures were almost as elastic as the rubber itself.



With the inadequacies of former "burst" devices in mind the Henry L. Scott Company sent samples of identical knit goods to widely scattered parts of the country with the request for results of tests on Scott "burst" testers in their laboratories. The resulting figures showed a striking standardization and all tests, too, were made by inexperienced operators.

First of all, the attachment fits onto many of the standard Scott Testers. The two major parts of the attachment replace the regular tensile strength testing jaws. The conversion of the Scott Tester from a tensile to a burst strength and vice versa is a matter of but a few minutes.

The upper part of the attachment, containing the bursting ball gets the tension of the inclinable balance. The lower half moves downward with the pull of the testing machine screw. This section of the attachment contains the ring, through which the fabric is forced by the bursting ball, and a clamping device with which to fasten the fabric and hold it taut. To operate, the section of knit goods is laid on the clamping base, the testing ring is lowered by means of a screw wheel holding the fabric securely. The screw mechanism of the testing machine pulls the fabric and ring down onto the ball until the fabric is broken or burst.

The bursting strength is indicated on the dial of the machine or the seri-graph recording sheet.

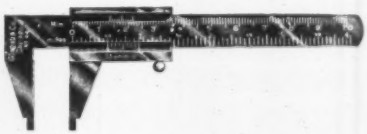
Extensive experimentation proved that a 1 inch ball and a 1¾ inch ring gave the best results, therefore, those sizes were adopted. As you may see from the foregoing, there can be absolutely no depreciation, reduced strengths or eccentricities of the testing parts. They are constructed entirely of metal. Nothing to wear or break.

Stainless Pocket Caliper

(Glogau & Co.)

THE illustration shows a new pocket caliper of non-rusting steel with visible numerals at the right and left side of the vernier, and the bar, entire measuring length right up to 4 inches or 100 mm. Overall length of instrument is 5¼ inches.

Both inside and outside measurements can be made. The vernier reads and can be used to figure 1/128 of an inch or 1/10 mm. The vernier slide is arranged in such a way that it will not move after the measurement has made unless touched. No screws or parts can be lost.



It can be operated with one thumb, having a sliding knob at the bottom of the rule which moves it both ways very easily and in addition this knob does the work of a micrometer screw. The caliper with the case weighs only 2 oz.

ENGINEER

Desires position with instrument manufacturer on research, experimental, development or investigation work in connection with mechanical, electro-mechanical and automatic equipment. Box 4, INSTRUMENTS PUBLISHING CO., Pittsburgh, Pa.

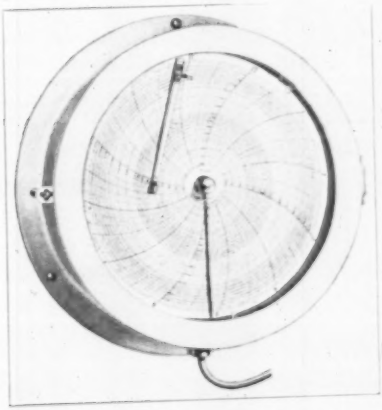
SMOKE RECORDER

Want to rent for a time, may purchase. To record duration of period of smoke from boiler furnace. Write

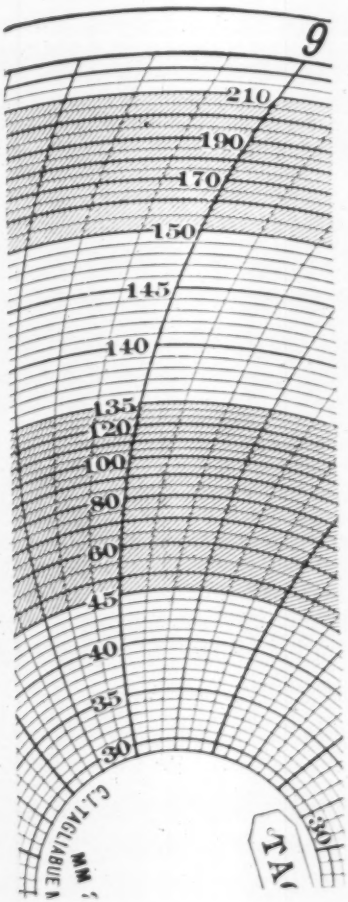
JOHN A. GRAHAM,
Drawer G., Oakland Station, Pittsburgh, Pa.

New Recording Thermometer for Milk Plants

THE C. J. Tagliabue Mfg. Co. has just placed on the market a radically new recording thermometer especially designed for use in milk plants. The feature of this new instrument is the chart, a section of which is illustrated herewith.



The proper pasteurization of milk demands that it be held at exactly 145° Fahrenheit for 20 minutes, or at exactly 144° for 30 minutes—the exact temperature and duration varying in different states. It is necessary to maintain this pasteurization temperature and duration with great accuracy. Therefore the recording thermometer chart desired by all milk plant men should have a printed scale with very wide graduations around this point.



Similarly, the "cooling range" must have wide graduations. The same holds true for the "sterilization range" around the temperature of boiling water.

Now, to have a printed scale with wide (say 1/16" per degree) graduations all the way from 30° to 215° Fahrenheit would mean a chart twenty inches in diameter, with inevitably high costs of instruments and charts.

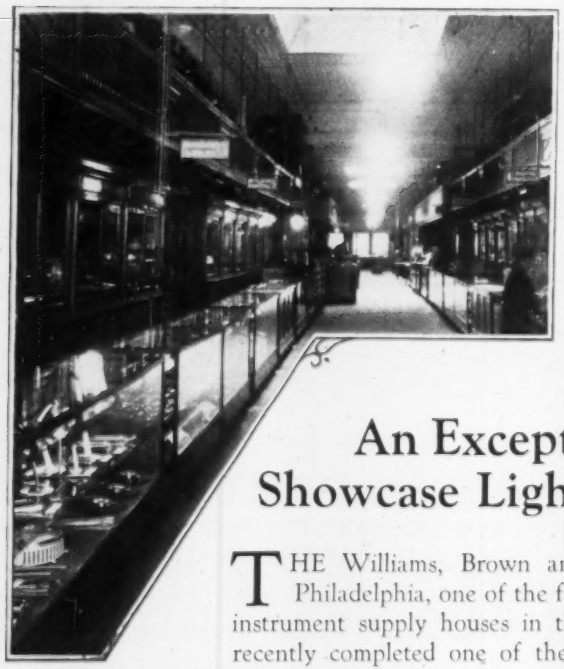
The Tagliabue concern has solved the problem by devising a special mechanism for their standard record-

ing thermometer, whereby the motion of the pen arm is stepped up between 30 and 45° F. and between 135 and 150° F., while between 45 and 135° F., and between 150 and 210° F. the motion of the pen arm is cut down.

This "fast-and-slow" motion of the pen arm is obtained by means of a series of cams actuating one roller, in turn. Thus a "steep" cam causes a fast motion from 30 to 45° F. and then a "flat" cam causes the slow motion from 45 to 135°, and so on.

It is claimed that this new instrument, with its special chart, meets all demands of milk plant work throughout the United States and Canada, as it fulfills the most rigid requirements of the various State, Provincial and municipal health authorities—no matter how widely these regulations may differ among one another.

The diameter of the chart of the new TAG instrument is exactly ten inches, and the width of the graduated scale portion is four inches. The pasteurizing and cooling portions of the scale are graduated in single degrees, the degree lines being 1/16" apart.



An Exceptional Showcase Lighting Job

THE Williams, Brown and Earle Co. of Philadelphia, one of the foremost scientific instrument supply houses in the country have recently completed one of the finest showcase installations in any firm of its kind.

One very unique feature of this installation is the fact that each case is complete in itself and may be interchanged with any other. In other ways, the installation is 100 per cent portable. This feature also applies to the wall cases which were lighted at the same time.

The Research Air Flow Indicator

(Commercial Engineering Laboratories)

THE exact measurement of the air consumption of internal combustion motors has not been an easy matter and, therefore, many of the important motor characteristics which depend on the study of air flow have had little attention. The elementary means of measuring air flow is by the displacement tank or gasometer. This method when properly used is very exact but it is not a continuous method because the displacement tank will not supply sufficient air for a long test and it is often necessary to refill it during a single run. An equipment of sufficient capacity for the average automobile motor is so large that it must be permanently installed and cannot be moved about.

The instruments most commonly used are the venturi meter and the orifice meter. These two methods are quite similar and depend on the change in pressure of an air stream when its velocity is changed by a tapered restricted passage or a small opening in a thin plate. This change in pressure is read on a water manometer and the air flow corresponding thereto is read from a chart. A given orifice or venturi has a very limited range and a set of three to five must be provided to cover the usual range of automobile motors.

The need of an instrument for measuring air flow which would give direct readings in cubic feet per minute, which would not change its accuracy under long and continued use, and which could be readily moved about, led to the development of the "Research" Air Flow Indicator, which has been accepted by many of the largest automotive laboratories as the most satisfactory instrument for this purpose. The "Research" Air Flow Indicator is built into a carefully finished mahogany cabinet 18 inches wide, 20 inches deep and 72 inches high.

The cabinet contains all of the operating mechanism and is mounted on four rubber tired casters which can be raised and lowered, thereby permitting the instrument to be moved easily about or to stand rigidly on the floor. The cabinet contains a small variable speed direct current motor, which can be supplied for either 110 volts D. C., or 220 volts D. C. The connection is made to a suitable current line by a flexible rubber covered cable. Standard galvanized iron conduit four inch diameter is used for connecting the instrument to the carburetor or intake opening of the device to be measured, and the joints are sealed by friction tape. This method of attachment is the simplest and most efficient.

The metering tubes are located in the lower part of the cabinet which also contains a small motor driven blower which is used to build up air pressure to overcome the resistance of the instrument and connecting pipes so that atmospheric pressure can be maintained at

any given point in the line. A manometer indicates when atmospheric pressure is obtained at any given point. The pressure effect is adjusted by a knob on the front of the cabinet and also by a rheostat which controls the motor speed. The cabinet also contains a pulsation dampening device.

Each instrument is calibrated separately and has its own scales made on a dividing engine. The construction of the instrument is such that its calibration will remain unchanged under any conditions of normal usage.

The Research Air Flow Indicator has many uses in the automotive laboratory. As part of a bench test equipment (where the air flow is obtained by a vacuum pump) it enables the engineer to test carburetors, manifolds, valve ports, and cylinder heads.

The study of carburetors alone is an enormous field and includes the measuring of the fuel air ratio, the flow resistance of the carburetor passages, the effect of throttle positions, and the effect of air cleaners on the total resistance and the fuel air ratio.

Manifolds, valve ports, and cylinder heads can be studied in detail by using wood models which can be easily modified by using wax. The comparative flow resistance of various forms can be easily measured from models and the designs worked out carefully before patterns and castings are made. The completed designs can later be checked under actual operating conditions.

The Research Air Flow Indicator is the greatest improvement in air measuring devices in many years, and with it the engineer can undertake the study of air flow with confidence.

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The Research Fuel Flow Indicator

(*Commercial Engineering Laboratories*)

THE Research Fuel Flow Indicator is a very carefully made laboratory instrument which indicates at any instant the exact rate of flow (in gallons per hour) of the fuel being used. It will replace in many instances the more cumbersome methods of measuring or weighing, and the results are obtained in a small fraction of the time.

The instrument, which is assembled in a carefully lacquered brass shell, is made up of the metering tube, a brass cylinder with specially machined and lapped taper bore mounted in the lower part of the shell, and the metering unit which consists of a special alloy metering head and a reading disc assembled on a light alloy shaft. The metering head floats in the metering tube and the shaft is of such length that the reading disc is always visible in the glass tube which occupies the upper part of the shell.

When no fuel is flowing the metering head is at the bottom of the metering tube and the reading disc is at zero on the scale. Any flow of fuel through the instrument lifts the metering unit, and the reading of the scale opposite the black line on the reading disc is the correct flow in gallons per hour.

Two types of Research Fuel Flow Indicators are available, Type Nine which has a nine inch scale and is twenty-two inches long over all, and Type Eighteen which has an eighteen inch scale and is forty-two inches long over all. The construction of the two instruments is the same. The normal capacity of the Type Nine is ten gallons per hour, and of the Type Eighteen is twelve gallons per hour. These capacities cover all usual conditions but can be varied for special requirements.

The Type Eighteen is the more sensitive instrument, and its eighteen inch scale gives a very close and accurate reading. The design and construction of the two instruments is the same. The Type Nine instrument is most suitable for use on cars making road tests, while the Type Eighteen is best adapted to laboratory work.

The Research Fuel Flow Indicator is the most practical, the most compact, and the most accurate instrument of its kind. It will operate indefinitely under normal conditions. It will enable the engineer to make tests not heretofore possible, and to make routine tests in a fraction of the time required by the older methods.

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The Research Twin Burette Fuel System

(*Commercial Engineering Laboratories*)

THE Research Fuel System is used for fuel measurements when cars are tested under actual operating conditions on the road. When combined with the Type Nine Flow Indicator it provides the most useful and most complete fuel test equipment for road work available today.

This equipment is usually installed on the windshield of the car at the extreme right where it does not obstruct the driver's view and is conveniently located for the observer. A small fuel pump in the supply line lifts the fuel to a float bowl. The burettes are filled from the float bowl. The observer controls the flow to and from the burettes by a small knob.

All the fuel used by the motor passes through the flow indicator which shows at all times the rate of flow in gallons per hour and indicates the rapid change in fuel flow caused by acceleration, hill climbing, coasting and idling. It gives an accurate moving picture of the

fuel requirements, which is supplemented by specific measurements of volume which can be made by the burettes. The various settings of the control valves provide suitable tests for any one of the many operating conditions encountered.

A continuous record of time, distance, and fuel over any given course is a most useful test made possible by the Research Fuel System. For this test the observer uses a log sheet of four columns. The first is numbered for fuel increments (quarts usually, although any increment may be used) from one up to the estimated number required for the trip. The second column is for the odometer readings, the third for time and the fourth for notes. While the fuel is being used from one burette, the other is filled from the float bowl. When the fuel reaches the low mark on the first scale the knob is turned and the flow continues without interruption from the second, when the first is again filled ready for use.

From the log sheets the results can be shown graphically on plotting paper in terms of distance in miles, fuel in miles per gallon and speed in miles per hour. These tests can be made to cover ten miles or one thousand miles and provide a new and valuable comparison of equipment changes on one car or of different cars.

All routine work, such as inherent economy tests at all speeds can be made with this equipment, in much less time than ever before. There is no waiting for burettes to fill, or delay in adjusting the level.

Fuel readings can easily be taken for each run of a series of acceleration tests and at the end of the series the total reading is the sum of the individual readings. This is done by a valve setting which permits the fuel for each run to be taken from one burette without fuel being added between runs. This is another new and useful test made possible by the Research Fuel System.

This method also applies to hill climb tests where its value has been proven. A slight difference in the fuel used sometimes represents the difference between success and failure.

The Research Fuel System is also suitable for panel mounting in the dynamometer room. It replaces other forms of burettes, flow indicators, and weighing devices, none of which will enable you to take instantaneous readings of the flow as well as accurate measurements of volume. For laboratory installation the Type Eighteen Flow Indicator is used as the longer scale can be read more accurately.

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Mr. C. E. George, for many years Western manager of the American Schaeffer & Budenberg Corp., has recently joined the sales staff of the Taylor Instrument Companies of Rochester, N. Y. He will be associated with the Chicago Office of the Company with headquarters at 58 East Washington Street, Chicago, Ill.

New Combustion Meter

(*Hays Corporation*)

THIS highly refined machine can be furnished to record CO_2 in combination with either furnace draft or flue gas temperature or as a combined recorder for CO_2, draft and flue gas temperature.

The same accurate Orsat principle of operation which has characterized its predecessors is retained in the new Model "C", the changes having been made in the recording rather than the analyzing parts. Suspended pens, a 10 inch circular chart and a new silhouette type aluminum chart case with polished aluminum door are features of the Model "C". Another feature is the draft attachment, the pen of which is actuated by our special slack leather diaphragm which has been used so successfully in Hays Pointer Type Draft and Pressure Gages. The most sensitive range gives a pen movement of two and one half inches with a draft of two tenths of an inch water.

Hays Combustion Meters, Model "C", come completely equipped with ink, 100 charts, six to eight months' charge of caustic potash solution in liquid form, water strainer, double length porous carborundum soot filter and wall sleeve for making this filter easily removable.

Where water conditions are bad or where a portable CO_2 recorder is desired for periodic tests on several boilers, the Hays Combustion Meter can be furnished with a motor driven pump to recirculate water from a three gallon tank mounted inside the supporting base of the instrument. For portable work a special three wheel truck of ingenious design is furnished.

New Hays Boiler Panel

(*Hays Corporation*)

THIS is a U-shaped panel of quarter inch steel boiler plate with a metal enclosure for the top and hinged steel doors at the rear. The valves, pipes and wiring for the several instruments are conven-

iently accessible through these doors and yet they are protected and neatly concealed from view. Slate fronts can be used rather than steel if desired.

These instrument panels are usually laid out and built to suit the requirements of the particular plant. They represent the modern trend and express the recognized importance of instruments in present day power plant practice and efficiency.

The aluminum case which encloses the recording parts of the Hays CO_2 Recorder has been so designed that it may be flush mounted as shown, the analyzing parts being housed in a separate case at the rear. A companion Recorder using the same type of aluminum case records steam pressure and temperature. The Hays Pointer Gage, with proper number of scales, for air pressure, furnace draft, etc., can be mounted either flush or semi-flush, depending upon the height above the floor. Any type of steam flow meter may be mounted on the Hays Boiler Panel.

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Five new seismographs are being built for the use of Father Ricard, Santa Clara University's "Padre of the Rains."

The instruments will be installed in steel and concrete vaults completely underground, but will be connected with the out-of-doors by a concrete tunnel.

Three of the instruments are being built in Esthonia by Prof. Masing and two at Pasadena, Cal., by Prof. Frederick Hensen.

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Instruments Book Shelf

IN this section the recent books on instruments, measuring devices, tests, inspection and control, etc., will be reviewed.

Orders for copies of the books reviewed there, can be sent to INSTRUMENTS BOOK SHELF, c/o INSTRUMENTS PUBLISHING COMPANY, 1117 Wolfendale Street, Pittsburgh, Pa.

M. J. L. Indicating Flow Meter

MOREY, JONES & LOVELL, Inc., have placed on the market their new Series "C" Flow Indicator which is capable of indicating rates of flow of air, gases, both saturated and superheated steam, oils, water, and various special commercial liquids, perfumery, syrups, etc., flowing at any temperature, pressure, vacuum, in any commercial size pipe line.

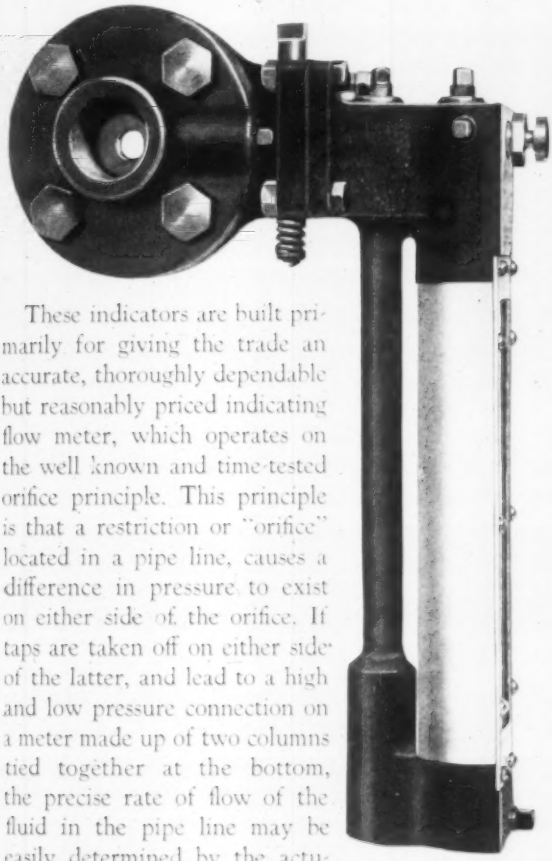


Fig. 1

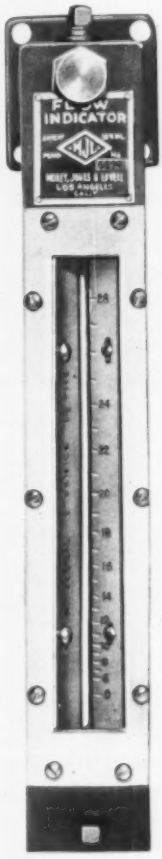


Fig. 2

These indicators are built primarily for giving the trade an accurate, thoroughly dependable but reasonably priced indicating flow meter, which operates on the well known and time-tested orifice principle. This principle is that a restriction or "orifice" located in a pipe line, causes a difference in pressure to exist on either side of the orifice. If taps are taken off on either side of the latter, and lead to a high and low pressure connection on a meter made up of two columns tied together at the bottom, the precise rate of flow of the fluid in the pipe line may be easily determined by the actuation of a column of mercury or other indicating liquid, in the meter or indicator.

Orifices may be made of any desired metal; steel and bronze being ordinarily used, but monel metal often furnished where a non-corrosive disc is required. The MJL Indicator Body itself is made up of two "legs"; the rear one being of large mercury capacity at the bottom, and made of seamless Shelby tubing; the front one being of Pyrex heavy-

walled glass tubing, the inside diameter of which is considerably smaller than that of the steel tubing of the back "leg." Thus, the greater part of the mercury "deflection" occurs in the glass leg, and any errors that might be introduced by reason of a variation in machine-work of the instrument, or the inside bore of the glass is minimized. The reading of rate of flow is thus entirely taken from the position of the mercury in the glass; no difference of level reading being necessary. And the desirable feature of this indicator is that the scale may be marked in any direct-reading units the purchaser prefers; such as G. P. M. of water, gals/day of oil flow, cu. ft. pere min. of air, and so on. Thus he does not have to refer to a table or chart to know his exact rate of flow.

Here are some of the more salient advantages of the MJL Flow Indicators:

Accurate as modern scientific methods can make them—the first requisite of any make of meter.

Compact, and easy to install in any size pipe line. This refers to such features as the "close hook-up" type shown in Fig. 1.

Simple in construction and principle; with entire absence of gears, wheels, and other intricate moving elements.

"Fool-Proof" in design, as nearly as sound engineering can make them: this refers to such features as the "non-blow-over" of the mercury column under abnormal conditions of flow.

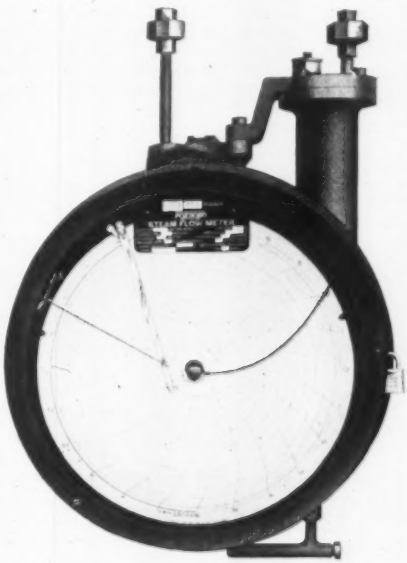
Neat in appearance and especially sturdy in make-up.

The very best of material is used in the building of these flow indicators. Top and bottom castings or the indicator body being of high grade, special mix semi-steel, carefully inspected and tested before being put into the instrument. Rear leg of seamless steel tubing, and the top and bottom pieces are set together accurately by means of said tubing, which is carefully brazed in place. This accurate setting permits of neat connection of the nickel-plated housing piece which supports the scale plate on which the rate of flow scale is marked with great care. Housing piece and scale plate are stampings, and fit the instrument exactly. Thus, not only a real, pressure tight job is guaranteed, but an especially neat appearance is secured. A by-pass valve is provided so that the pressure may be "equalized" between the two legs of the instrument; and any entrapped air resulting from operation, is removed. Divisions on scale plate can be made to almost any degree of fineness desired, within the limits of good visibility.

Steam Flow Meter

TO meet the demand for accurate steam flow meters the Foxboro Company, Foxboro, Mass., have built an instrument upon principles that have been accepted throughout the world. The design of the new Foxboro Steam Flow Meter is based on that of the Foxboro Orifice Meter which has been extensively used for many years for the measurement of gas flow under field conditions where a rugged simple mechanism of high precision is necessary.

The basic principle is that of an ordinary U tube. Any change in differential pressure due to change in the rate of flow, forces mercury to move up or down. A machined steel float which rests on top of the mercury and moves with it causes a pen-arm on the front of the instrument to record the slightest variation in differential.



The instrument is calibrated to read and record in terms of flow and is equipped with an integrator that reads direct without multipliers, the total pounds of steam that have passed through the pipe. The integrator is a simple, accurate, dependable mechanism driven by an electric clock, or a spring-wound clock if preferred. Once each minute it adds on the counter the number of pounds of steam that have flowed through the pipe during that minute. For example, if steam is flowing at a rate of 56 lbs. per minute, the integrator will add 56 to the total indication of pounds of steam. The chart reads direct in pounds per hour.

This new meter is fundamentally accurate because it is of a simple mechanical design in which friction is reduced to a minimum and a large powerful float is employed, the motion of which is transmitted without angularity (Harmonic motion), and because the steam coefficients were carefully determined after extensive research and experimentation covering a period of years. This program of research included a complete series of steam flow tests at the Massachusetts Institute of Technology.

The new meter is a single unit. It has no electrical devices, special compensators, balances or stuffing boxes, and requires no maintenance except to change the chart and ink the pen.

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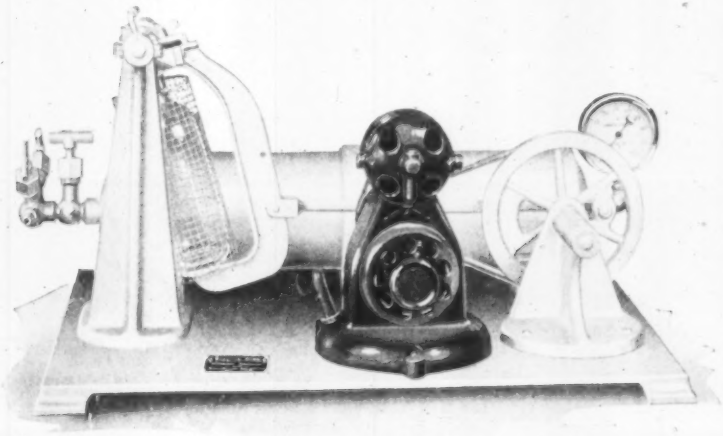
Catalytic Hydrogenation Apparatus

(Burgess-Parr Company)

THE Burgess Catalytic Apparatus, Illinois Model, is finding extensive application in the study of the synthesis of organic compounds, and in the determination of the relative efficiency of various catalysts. It was developed by Dr. Roger Adams and his associates at the University of Illinois, to facilitate their research in these problems. Many other laboratories, both educational and industrial, have required such an instrument. Manufacturers of explosives, synthetic perfumes, and special organic compounds, are representative of those who are finding this device useful.

The Burgess-Parr Catalytic Apparatus consists of an oscillating mechanism operated by an electric motor, which shakes a glass bottle in which the reaction being investigated proceeds. A supply tank for hydrogen is mounted on the base of the instrument, and is filled through a special needle valve from a source of the compressed gas. A gauge attached to the supply tank registers the pressure of the hydrogen held within it.



When the solution to be hydrogenated and the catalyst have been put in the bottle, it is sealed at the top by a stopper which has an inlet leading to the hydrogen tank. The shaking mechanism is started, which provides intimate contact between the solution, the hydrogen, and the catalyst. By noting the drop in pressure inside the supply tank, the amount of hydrogen absorbed in the reaction is measured. This provides a means for determining the extent to which the reaction has proceeded, and gives an index of the relative efficiencies of the various

catalysts which may be used. Likewise, the rate of reaction can be determined.

Power is derived from a 1/20 h.p. constant speed motor, for 110 V., 60 cycle current. Speed changes may be obtained by attaching any one of three pulleys supplied with the instrument. Rates of oscillation are as follows:

200, 250 or 300 per minute.

A special variable speed motor can be supplied if desired. The bottle is made of flint glass, and is sufficiently strong to withstand the pressures used. The hydrogen supply tank is of seamless brass tubing with bronze headers, and is tested at 150 lbs. pressure. The needle valves are of tobin bronze with Monel metal stems, and are successfully used to reduce pressure and provide an even flow.

In the design of this instrument, the needs of the laboratory chemist have been of paramount importance. The apparatus has been made as light as a sturdy construction will permit, and possesses the advantages offered by compactness and completeness.

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Automatic Control of Acid Bath

Bulletin No. 500 of Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, contains a general description of this device as well as information on the care of the instrument.

Automatic Kilnboy

The Foxboro Company, Foxboro, Mass., has just issued Bulletin No. 160 which describes a device for weighing the samples of lumber for moisture content.

Applications of the Spectograph

Adam Hilger, Ltd., 24 Rochester Place, Camden Road, London, H. W. 1., England, has issued a leaflet covering "Recent Applications of the Spectograph to Metallurgical Analyses."

Automatic Fire & Damper Control

Bulletin 10-B of Morey, Jones & Lovell, Inc., 922 S. Hemlock St., Los Angeles, Calif., briefly describes their control for oil and gas burner installations.

Bausch & Lomb Magazine

The November number of the Bausch & Lomb Magazine issued by the Bausch & Lomb Optical Co., Rochester, N. Y., contains the following: Orthogon Unites Accuracy and Service; There is an Optical Santa Claus but you must let Him in.

Becker's Sons Balances & Weights

E. H. Sargent & Co., 155 E. Superior St., Chicago, Ill., have issued a bulletin describing this line of balances and weights.

Calipers

Glogan & Co., 538 South Clark St., Chicago, Ill., have issued leaflets on their Pocket Caliper No. 44 and "One-thumb Operating" Vernier Caliper.

Catalytic Hydrogenation Apparatus

Publication No. E1 issued by Burgess-Parr Company, Moline, Illinois, covers their apparatus for Catalytic hydrogenation.

Chemist Analyst

The J. T. Baker Chemical Co., Phillipsburg, N. J., in the October issue of the Chemist Analyst have a number of very interesting articles, one of which is "The Pyconometer, its Standardization and Uses, with some notes on the Accuracy of the Instrument."

Coordinatograph-Polar

G. Coradi, 49 Weinbergstrasse, Zurich, Switzerland, has a reprint describing their polar coordinatograph. This is printed in English.

Chettick CO_2 Apparatus

E. H. Sargent & Co., 155 E. Superior St., Chicago, Ill., in a leaflet describes the use of this apparatus for the determination of CO_2 of baking powders.

Davey Vibrometer

A leaflet on this instrument for the measurement of vibration has been issued by Vibroscope, 11 Broadway, New York, N. Y.

Dial-Indicators

A leaflet illustrating a few of the applications of Federal Precision Dial Indicators can be obtained from the Federal Products Corporation, Providence, R. I.

Diagram Planimeter

Leaflet A4 issued by G. Coradi, 49 Weinbergstrasse, Zurich, Switzerland, describes this instrument. This is printed in English.

Electric Extraction Apparatus

This apparatus is described in a leaflet issued by E. H. Sargent & Co., 155 E. Superior St., Chicago, Ill.

Experimenter

The November issue of the General Radio Experimenter, Cambridge, Mass., contains the following: Rating of Radio Receivers; High Voltage Plate Supply Units.

Etalon for Wavelength Measurements

A leaflet of Adam Hilger, 24 Rochester Place, Camden Road, London, H. W. 1., England, covers the Fabry-Perot Etalon with variable separation.

Gas Analytic Apparatus

Dr. Siebert & Kuehn, Cassel, Germany, have issued a bulletin covering the use of "Deutz" Gas analytic apparatus. This is printed in German.

Gas Regulation of Coke Plants

The Shallcross Control Systems Co., Milwaukee, Wis., has available a bulletin which covers the above subject.

Hydrogenation of Oils Apparatus

Is described in a leaflet issued by A. Daegger & Co., Chicago, Ill.

Hydro-Thermograph

Julien P. Friez & Sons, Baltimore, Md., have a new bulletin on their Hygro-Thermograph for recording temperature and relative humidity directly on the same chart.

Instrument Investment News

The November issue of the Instrument Investment News, American Schaeffer & Budenberg Corp., 338 Berry St., Brooklyn, N. Y., contains the following articles: Paper at a Mile a Minute; Setting the Twist in Silk with Maximum Efficiency; One Little Instrument is a Guarantee Against Loss Combustion Control Makes for Boiler House Economy.

Fractionating Apparatus—Low Temperature

A leaflet of The Refinery Supply Co., Fourth & Detroit Sts., Tulsa, Okla., described their apparatus for the analysis of volatile hydrocarbon mixtures.

Pantographs

Freely suspended precision pantographs are described in a bulletin of G. Coradi, Zurich, Switzerland. This literature is printed in English.

Price List

Geodetic Instrument price list has been issued by Neuhoefer & Sohn, Wein, V, Austria.

Rheostats

The Coilton Electric Mfg. Co., Easton, Penna., has issued a leaflet on Coilton Sliding-Contact Tube Rheostats.

New Improvements in Esterline Angus Instruments

Bulletin 1128, published by the Esterline Angus Company, Indianapolis, Ind., lists ten improvements in the Esterline Angus Instruments.

The Laboratory

Vol. One, No. Five, of The Laboratory published by the Technical Service Department of the Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa., contains the following interesting articles: Joseph Priestly, The Clergyman-Scientist; Fused Quartz Laboratory Apparatus Made by New Methods; Determinations of pH simplified by Permanent Color Standards; Laboratory Apparatus Breaks Into Society.

Localvariometers

Print 1 published by Toffler & Co., Potsdam, Neue Koenigstr. 22, Germany, covers the field-balances manufactured by them. This leaflet is printed in English.

New Balloon Theodolite

Leaflet M114 published by Gustav Heyde, Dresden, N151, Germany, briefly describes their new Theodolite H1004. This is printed in German.

Regulator

Catalog No. 3 of D. H. Skeen & Co., 533 West Jackson Blvd., Chicago, Ill., covers Mercon Regulation for Feed Water Excess Pressure, Constant Reduced Pressure, Constant Back Pressure and Constant Differential.

Brinell Microscope

Bulletin 56 issued by Paul E. Hermann, Keenan Bldg., Pittsburgh, Pa., describes new type of Brinell Microscope.

Miniature Current Transformer

The Weston Electrical Instrument Co., Newark, N. J., have published Circular AA briefly describing and illustrating their miniature Current Transformers.

Regulation of Coke Plant Stack Draft

Is the title of a bulletin of The Shaffer Control Systems Co., Milwaukee, Wis.

Surveying Instruments

Catalog No. 28 of Brandis & Sons, Inc., 754 Lexington Ave., Brooklyn, N. Y., covers the Brandis Surveying Instruments and Field Equipment.

Thermometers

Bulletin No. 31 of A. E. Moeller Company, 261 Sumpter St., Brooklyn, N. Y. describes a new improvement in thermometers—the "Moeller Glass" Read Reading Column for Mercury filled Thermometers.

The Thermometer and Some Notes On its Manufacture

Is the title of a bulletin issued by A. E. Moeller Company, 261 Sumpter St., Brooklyn, N. Y.

Vibroscope

The vibroscope is described and illustrated in a leaflet issued by The Vibroscope, Inc., 11 Broadway, New York, N. Y.

Water Works Journal

The October issue of the Water Works Journal published by the Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, contains the following articles: A Million-Dollar Addition to the Water Supply Works at Pawtucket, R. I.

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Current Literature Review

Abstracts on instruments of interest to instrument readers

Acoustic Laboratory an Aid in Making High Grade Musical Wire. W. B. White. Ir. Tr. Rev., Nov. 1, 1928, pp. 1109-1122.

The equipment of the laboratory is briefly described.

Equipment for Routine Spectral Transmission and Reflection Measurements. H. McNicholas. B. of S. Jl. Res., Nov. 1928, pp. 793-857.

This paper presents a description of an assembly of apparatus which has been in use at the Bureau of Standards since August, 1924, for routine spectral transmission and reflection measurements. The Koenig-Martens spectrophotometer is used with different light sources, each source being designed especially to meet the required conditions of illumination on the sample in the measurement of the following quantities as functions of wave length:

1. The undirectional normal transmission of an optically homogeneous (nondiffusing) material in the form of a plate with plane-parallel surfaces.

2. The normal brightness of a sample by reflected light, relative to the same for a standard material, when both sample and standard are under equal and completely diffused illumination.

Accessory equipment includes ventilation apparatus, convenient devices for handling the transmission and reflection samples, standard sectored disks for use with the spectrophotometer, and apparatus for temperature control of liquid transmission samples.

The theory of the Koenig-Martens spectrophotometer is given, along with a discussion of some possible sources of error in the spectrophotometric measurements.

Tests of the accuracy in the measurement of the specified quantities are described.

Devises Electrical Method to Detect Flaws in Rails. E. A. Sperry, Ir. Tr. Rev., Nov. 15, 1928, pp. 1244-1246.

Article describes the new electric method devised for the nondestructive testing of steel rails.

Using Meters to Prevent Power Waste. W. S. Everham, Power, Oct. 16, 1928, pp. 635-636.

This article describes the installation of instruments at the Norwich Pharmacal Company, Norwich, N. Y.

Thermal Expansion of Magnesium and Some of its Alloys. P. Hidnert and W. Sweeney, B. of S. Jl. Res., Nov. 1928, pp. 771-792.

Three types of apparatus were used in this research, and a summary of available data by previous observers on the thermal expansion of magnesium and some magnesium alloys is given.

Flow Measuring Devices for Hydroelectric Plants. Power Pt. Engg., Oct. 15, 1928, pp. 1102-1104.

Abridged from a report of the N. E. L. A. Hydraulic Power Committee. The article covers the various devices employed, all of which utilize pressure differentials developed by existing features of station design.

Meters—Essential to Good Management. John W. Romig, Power, Nov. 13, 1928, pp. 786-789.

The advantages of weighing and metering devices is taken up.

Automatic Boiler Control Compared with Manual Operation. A. S. Griswald, Power, Oct. 30, 1928, pp. 710-712.

This article gives a result of a study now being carried on on Smoot equipment at the Beacon Street plant of the Detroit Edison Co.

Power Plant Efficiency Increased by Application of Chemistry. H. C. Dinger. Power, Oct. 30, 1928, pp. 714-716.

Various applications of chemistry to the power plant are considered.

Design of Tuned Reed Course Indicators for Aircraft Radiobeacon. F. Dunmore, B. of S. Jl. Res., November, 1928, pp. 751-769.

Six types of indicators were constructed and data obtained on each. The final model was one in which the reeds were made of steel with a bimetallic strip on the free end of the reeds for automatically holding the reeds in tune as the temperature varies. The reeds which are strongly polarized vibrate between two electromagnets taken from a telephone receiver. This form of indicator requires less than 1.5 milliamperes and 3.5 volts to operate the reeds with an 11 by 11 mm damper on the end of the reed. This damper served to increase the decrement of the reed, so that any slight change in the modulation frequencies would not change the reed deection.

The Purpose and Value of Instruments Particularly the CO_2 Recorder. W. G. Forbes, So. Power Jl., Nov. 1928, pp. 34-37.

Value of CO_2 meter discussed.

Aerial Photography in the Power Plant Industry. Power Pt. Engg., Nov. 15, 1928, pp. 1188-1191.

This article shows the application of aerial photography to preliminary power plant surveys.

Technical Control for Paper Board Mills. E. F. Whittington Paper Industry, Oct. 1928, pp. 1188-1189.

Abridgement of a paper presented at fall meeting T. A. P. P. I.

Application of Meters and Instruments in Pulp and Paper Mills. R. V. Knapp, Paper Industry, Oct. 1928, pp. 1190-1194.

The need for dependable and accurate meters and instruments for application to many phases of pulp and paper making are taken up.

Effect of Twist on Cotton Yarns. A. Mercier & C. Schoffstall, B. of S. Jl. Res., November 1928, pp. 733-750.

Measurements were made of strength, diameter, angle of twist, and contraction. Correlations of the results graphically with respect to the twist multiplier are shown and discussed. Suggestions regarding the application of these data to the cotton mill are given.

Technical Control in Soda Pulp Mills. E. S. Hinman, Paper Industry, Oct. 1928, pp. 1195-1197.

Abridged from paper before the Technical Association of the Pulp and Paper Industry.

A Useful Design of Tube-Voltmeter. W. F. Powers and G. W. Alderman, Jl. Opt. Soc., Nov. 1928, pp. 379-380.

Design of Voltmeter is briefly described.

Note on the Effect of Repeated Stresses on the Magnetic Properties of Steel. M. F. Fischer, B. of S. Jl. Res., Nov. 1928, pp. 721-732.

Changes in the magnetic properties of steel generally accompany changes in the other physical characteristics. This suggests the possibility of detecting and following the progress of a fatigue crack by magnetic methods. It is found, however, that the magnetic changes produced by repeated stresses above the endurance limit are not of a type which can be associated with the characteristic effect of a crack transverse to the direction of magnetization. The similarity of the observed magnetic changes with those brought about by the removal of externally applied static stresses indicates that the observed changes may be produced by the partial relief or redistribution of initially existing internal stresses. The fact that the magnetic changes brought about by understressing are of similar character though less in magnitude suggests that some of the beneficial effect of understressing may be due to partial stress relief.

A Device for Accurate Timing. H. L. Johnston, Jl. Opt. Soc., Nov. 1928, pp. 381-385.

The device is illustrated and described.

A Study of the Hydrogen-Antimony-Tin Method for the determination of Oxygen in Cast Irons. B. Kjerrman and L. Jordan, B. of S. Jl. Res., Nov. 1928, pp. 701-720.

A comparison of the vacuum fusion and the hydrogen-antimony-tin reduction methods for the determination of oxygen in cast-iron samples indicated that it is very important that lump samples rather than milled samples be used in either method in order to avoid erroneous results for oxygen due chiefly to the absorption of air and moisture on milled samples and, in a lesser degree, to surface oxidation.

On the Lag Error of the Cup Anemometer with Oscillating Wind Intensity. (Ueber die Traegheitsfehler des Schalenkreuzanemometers bei Schwankender Windstaerke). O. Schrenk, Messtechnik, Oct. 22, 1928, pp. 275-278.

The results of the investigation are given as well as a short description of the test method.

Differential Pressure Measurement with Orifice, Nozzle and Venturi-tube and their choice. (Die Druckunterschied-Messung mit Messrand, Duese und Venturirohr und ihre Auswahl). A. Grunwald & F. Engel. Siemens Zeits., Oct. 1928, pp. 608-616.

Continued from a previous number. Nomograms for the choice of the primary elements are given.

Methods for the Determination of Elasticity Constants. (Methoden zur Ermittlung der Elastizitaetskonstanten). H. Stending, Messtechnik, Oct. 22, 1928, pp. 259-263.

General information on elasticity constants is given. The physical and technical methods are discussed.

The Advancement of Ceramic Physical Tests After the War. (Die Fortschritte des keramischen Materialpruefungswesens in der Nachkriegszeit). E. Kieffer, Messtechnik, Oct. 22, 1928, pp. 263-275.

The developments in Germany and the United States are taken up.

Test of Winding Insulation of Spools by means of High Frequency Tests. (Pruefung der Windungsisolation von Spulen mittels Hachfrequenz-Spannungen). D. I. Liebscher & D. I. Ziegler, Siemens Zeits, Oct. 1928, pp. 581-587.

Method of operation is given and illustrated.

Experiences and Improvement in the Construction of Cable Testing Devices for High Current D.C. (Erfahrungen und Fortschritte im Bau von Kabelprueflenrechtiungen fuer Gleichspannung). H. Mehlhorn, Siemens Zeits, Oct. 1928, pp. 590-596.

The apparatus is described and illustrated.

A New Brush Testing Device. (Eine neue Buersten Pruefeinrichtung). J. Kozisek, Siemens-Zeits, Oct. 1928, pp. 596-599.

A new apparatus for the testing of commutator brushes is covered by this article.

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Instruments Save Money. W. H. Scott, Power, September 25, 1928, pp. 508-510.

The article shows a saving of $10,600 yearly at Merrimac Chemical Company by use of flue gas thermometers, CO_2 recorder and steam flow air-flow meters and steam meters.

Measurement of Hydraulic Turbine Gate Leakage. E. Strowger, Po. Pl. Engg., October 1, 1928, pp. 1501-1502.

Abstract of portion of N.E.L.A. Hydraulic Power Committee Report. Six methods for leakage are given, with particular emphasis on that taking account of fall of Pressure in penstock.

Temperature Measurements in the Open Hearth Furnace. B. M. Larsen, Fuels & Fces., September, 1928, pp. 1163-1168.

The measurement of open-hearth temperatures is discussed.

Magnetic Analysis of High-Speed Steel. W. Kouwenhove & J. Tebo, Fuels & Fces., September, 1928, pp. 1179-1182.

Discussion of a magnetic method of distinguishing between high speed steel bars that are correctly heat treated and those that are not.

The Renaissance of British Instrument Making. W. H. Connell, Instrument World, October, 1928, pp. 165-172.

The article covers the development of the scientific instrument industry of England, with particular reference to the design and manufacture of surveying instruments.

The Measurement of Gaseous Refractivities. H. Lowery, Instrument World, October, 1928, pp. 176-177.

The author briefly discusses the use of the Jamin interferometer.

Industrial Applications of Ultra-Violet Rays. J. Mansell, Instrument World, October, 1928, pp. 178-180.

The various uses are briefly taken up: Food Products, Paper and Textile, Minerals and Metals, Rubber, Testing Inks, Oils, Testing Dyes, Durability of Coatings, Sterilization of Ultra Violet Rays.

Sir Charles Wheatstone, 1802-1875. Instrument World, October, 1928, pp. 185.

A brief History.

Aerial Navigation Examples. P. Weems, Aero Digest, October, 1928, pp. 670, 852.

The author illustrates by means of an example checking of position of airplane. Use of Sextant given.

True Altitude Meters. L. A. Hyland, Aviation, Oct. 27, 1928, pp. 1322-1323, 1356.

This article gives a resumé of the experiments conducted and the results obtained in the development of an accurate altimeter.

Automatic Machine Gaging. C. W. Robbins, Bell Jl., Oct., 1928, pp. 708-729.

This paper discusses the advantages to be gained in certain types of large scale production by the substitution of automatic machine gaging for hand testing.

An Integrating Photometer. M. G. Bennett, Proc. Phys. Soc. Lond., Aug. 15, 1928, pp. 316-319.

This paper describes a type of integrating photometer designed to measure the total amount of light arriving at a point on the earth's surface, from the sun and sky irrespective of the position of the sun or the distribution of the cloud.

Topography From the Air. L. J. R. Holst, Jl. Franklin Inst., Oct., 1928, pp. 435-470.

The requirements on equipment and methods and carrying out the work is given.

The Centrifugal Frequency Recorder. F. S. Stickney, Elect. Jl., Nov., 1928, pp. 547-549.

Instruments described and illustrated.

Oscillography. Joseph W. Legg, Elect. Jl., Nov., 1928, pp. 556-563.

This article is the 10th installment of this series of articles and takes up the expansion of the sphere of application by new galvanometers.

Methods of Testing Electrical Apparatus. Elect. Jl., Nov., 1928, pp. 563-567.

This installment of the article takes up tests on single-phase transformers not self cooled.

Inspection Methods and their Calculation. F. H. Colvin, Amer. Mach., Nov. 1, 1928, pp. 691-694.

This is the ninth of a series of articles and discusses the inspection of automobile camshafts.

Development and Use of Measuring Equipment. Amer. Mach., Nov. 1, 1928, pp. 685-688.

Brief history of measuring devices that are primarily manual, and an outline dealing with present day automatic and optical gages.

Recent Applications of the Electric Micrometer. A. V. Mershon, G. E. Rev., Oct., 1928, pp. 526-532.

A brief description of the instrument is given. Water pressure tests in a hydroelectric station. Balance and vibration tests on rotors of large steam turbines. Compression indicator diagrams of an electric household refrigerator unit.

Temperature and Brightness of the New Standard Type of Incandescent Lamp. W. E. Forsythe and E. M. Watson, G. E. Rev., Oct., 1928, pp. 532-534.

Article takes up features of design: coiled filament, few filament supports, and inside-frosted bulb. Tables of comparative temperature and brightness are given.

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MODEL CONSTRUCTION
Peterson, C. W.

Microanalysis. W. Garner. Ind. Chemist, July, 1928, pp. 287-290.

Various methods are described. Melting and boiling points, specific gravity, refractive index, solution, crystallization, and evaporation.—Abs. Bull. Kodak Res. Labs.

Automatic Control of Moisture in Paper. J. C. Callon and A. Allan. Pulp — Paper, June 28, 1928, pp. 885-887.

A moisture-sensitive ribbon is placed and shielded so as to be affected by the moisture of the paper only. This ribbon changes its length according to moisture content and moves a plate of a condenser which is part of a radio frequency oscillatory circuit. This in turn records the per cent moisture of the paper and can also be used to work steam control valves.—Abs. Bull. Kodak Res. Labs.

Simple Testing of Colors and Paints. Farbe und Lack. May 30, 1928, pp. 238-239.

Outlines revised tests for spreading, spraying, drying and covering power and resistance to water, sunlight, alkali and acids, etc.—Abs. Bull. Kodak Res. Labs.

Technic of Measuring X-ray Intensity. A. Eugster and A. Zuppinger. Forts. Gebiete Roent., Feb., 1928, pp. 194-212.

Report of critical observations made on the Kustner apparatus and Siemens dosagemeter. The Siemens dosage-meter may be in error on account of the failure of the audion tube, which needs frequent checking against a standard curve. The dosage measured in air depends on the diameter of the diaphragm and its distance from the diaphragm. Because of this the diameter and location of the diaphragm must be included in the specifications of measurements. Diaphragms smaller than 20 mm. in diameter may produce great errors. The Kustner apparatus gives practically the same dosage as the γ-independent Siemens meter in the deep therapy region.—Abs. Bull. Kodak Res. Labs.

Experimental and Theoretical Studies in X-ray Intensity Measurement. W. V. Mayneord. B. J. Radiol. April, 1928, pp. 125-138.

A standard ionization chamber is described for use in X-ray intensity measurements in an absolute electrostatic unit. Sources of error are discussed, especially those involved in the determination of the volume of air ionized. The quantity of X-radiation required to produce a change radiation employed. The pastille appears to be suitable in the region of 130 kv. peak or 0.50 of tint of 1B in a pastille has been determined; this quantity is variable with the quality of radiation employed. The pastille appears to be suitable in the region of 130 kv. peak or 0.50 A.U. wave-length.—Abs. Bull. Kodak Res. Labs.

Method of Determining Absolute Surface Area. O. Hahn. Ann. Chemfl, May 23, 1928, pp. 174-185.

The Paneth method (Z. Elektrochem., 28, 113 (1922); Z physik. Chem., 101, 1922, p. 445) of determining the specific surface of a precipitate, one of the elements of which has a radioactive isotope, has now been combined with a method of adsorption of any substance giving a radioactive emanation, for determining surface or change of surface.—Abs. Bull. Kodak Res. Labs.

Correct Stereoscopy. J. Swetkowski. Phot. Korr, May 1, 1928, pp. 152-155.

The suggestion is offered that stereoscopic pictures and the use of stereoscopic apparatus will become increasingly popular in industry. Industrial technical publications and catalogues may soon provide stereoscopic illustrations. The optical equipments for various macrostereoscopic requirements are discussed and extensive data for microstereoscopic work are given. Helpful formulas are given governing choice of ocular focal lengths, camera extension, and objective focal lengths to satisfy given conditions. The object of the article is to guide users into the correct method of employing stereoscopic apparatus.—Abs. Bull. Kodak Res. Labs.

Ballistic Milliammeter. H. Chantraine. Forts. Gebiete Roent., June, 1928, pp. 865-866.

A ballistic milliammeter is described for use with x-ray tubes. It measures within 5% the ma.-sec. in exposures shorter than 0.5 sec., and is especially useful for short exposures where high tube currents are required.—Abs. Bull. Kodak Res. Labs.

Ballistic Galvanometer Method of Potentiometric Measurement for High Resistance Cells. H. T. Beans and George H. Walden, Jr. Jl. Amer. Chem. Soc., Oct., 1928, pp. 2673-2678.

This describes a semi-deflection method using the circuit of Jones and Kaplan (Ibid., July, 1928, p. 1845), but modified, and capable for use with cells of 50 megohms resistance.—M.E.H.

Freezing Point Apparatus. Evald L. Skau and Blair Saxton. Jl. Amer. Chem. Soc., Oct. 1928, pp. 2693-2701.

A modification of the freezing point apparatus as given by Andrews, Kohman and Johnston (Jl. Phys. Chem. 29, 914) (1925) is described.—M.E.H.

Apparatus for Determining Sorption Curves. Hal D. Draper. Jl. Amer. Chem. Soc., Oct. 1928, pp. 2637-2653.

An apparatus is described for determining the sorption curves for certain oxidation catalysts in the form of porous granules.—M.E.H.

Measurement of the Temperatures of Stationary Flames. A. G. Loomis and G. St. J. Perrott. Ind. Engg. Chem., Oct. 1928, pp. 1004-1008.

A number of proposed methods for measuring the temperatures of flames are critically reviewed and the optical method of Kurlbaum-Fery is described and examined in detail. A diagram of the line-reversal apparatus is given.—M.E.H.

Flame Speed of Hydrogen Sulfide. D. S. Chamberlin and D. R. Clarke. Ind. Engg. Chem., Oct. 1928, pp. 1016-1018.

An apparatus and method for determining the flame speed of hydrogen sulfide in air by horizontal flame propagation are described. The flame records were made by photographic method. Diagram is included.—M.E.H.

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Advertisers Index

	Page
A	
Aloe, Co., A. S., 1823 Olive St., St. Louis, Mo.	536
Adde & Company, Portland, Maine	536
American Radiator Co., 40 W. 40th St., New York, N. Y.	1
B	
Bristol Co., The, Waterbury, Conn.	Back Cover
Burgess-Parr Company, Moline, Illinois	4
C	
Cargille, R. P., 26 Cortlandt St., New York	11
Colonial Supply Co., 217 Water St., Pittsburgh, Pa.	5
F	
Federal Products Corp., Providence, R. I.	11
Fennel Sons, Otto, Kassel 85, Germany	536
H	
Paul E. Hermann Co., Keenan Bldg., Pittsburgh, Pa.	3
Hoyt Electrical Instrument Works, 857 Boylston St., Boston, Mass.	536
P	
Peterson, C. W., 6243 Wentworth Ave., Chicago, Ill.	536
Pyrometer Instrument Co., 50 Howard St., New York, N. Y.	536
R	
Rawson Electrical Instrument Co., 90-92 Windsor St., Cambridge, Mass.	2
S	
Southwark Foundry & Machine Co., 400 Washington Ave., Philadelphia, Pa.	11
Sticht & Co., Herman H., 21 Park Row, New York, N. Y.	536
T	
Tagliabue Mfg. Co., C. J., 18 to 88 Thirty-third St., Brooklyn, N. Y.	Inside Front Cover
Taylor Instrument Co., 95 Ames St., Rochester, N. Y.	Inside Back Cover
W	
Wilson-Maulen Co., Inc., 18 Concord Ave., New York, N. Y.	10

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Gentlemen:

In the November issue of "Instruments" of which we are a subscriber, we observed on Page 23 a short description of a paper entitled "The Surging of Engine Valve Springs," Special Report No. 10, Department of Scientific and Industrial Research.

We are writing to ask where we could obtain a copy of this paper as we believe it would be helpful to us as manufacturers of internal combustion engines.

We might add at this time that "Instruments" is perused thoroughly by us every month with interest. We believe it is filling a long felt need and wish to congratulate you for your accomplishment. So far, we have found little information in the magazine about instruments used in internal combustion engine development and research. Might we ask that you give this phase of the field some little consideration in the future? We believe that the automotive and industrial engine manufacturers as well as the technical schools would greatly appreciate such information.

If you can give us the information about the paper herein requested, we would surely appreciate it. Wishing you continued success, we remain,

Very truly yours,
FULLER & JOHNSON MFG. CO.
(Signed) C. S. Hansen
Engineering Department

C. S. Hansen
KM

The above letter places the stamp of approval upon our efforts. It assists in substantiating our claim that INSTRUMENTS "fills a long felt need" and that the publication is "perused every month with interest." It is one of many we have received. We wish we could print every letter. Coming as they do at this season of the year they are appreciated. With this issue we have completed our first volume—our initial year—we hope to improve as we progress.

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INSTRUMENTS, Vol. 1, No. 12, December, pp. 503-505, 1 fig.

A brief biography, abridged from "Electrical Communication"

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A Direct-Reading Permeameter.

Frank P. Fahy, **INSTRUMENTS,** Vol. 1, No. 12, December 1928, pp. 507-513, 3 figs.

The construction and operation of the instrument is taken up. Method of carrying out measurement is also given.

Measurement of Specific Gravity of Varnishes, Paints, etc.

H. L. Hazeltine, **INSTRUMENTS,** Vol. 1, No. 12, December 1928, pp. 515-518, 3 figs

The methods of measuring specific gravity are mentioned. The use of the hydrometer is taken up in some detail.

New Specifications for Raw Materials.

J. R. Townsend, **INSTRUMENTS,** Vol. 1, No. 12, December 1928, pp. 519-521, 3 figs.

This article discusses the preparation of specifications and illustrates this by application to the preparation of a specification for bronze. Tests show the agreement between Rockwell hardness numbers and tensile strength.

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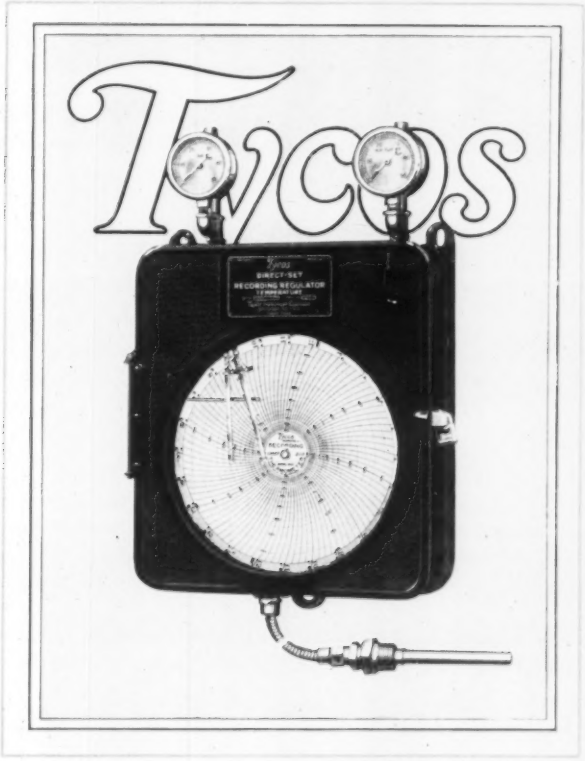

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WHAT three factors are used in most industries? Temperature, pressure, humidity. What do Tycos Instruments have to do with these conditions? They indicate, record or control them. How many different instruments do the Taylor Instrument Companies offer for this work? Over 8000. Will Tycos Instruments be of benefit in my line? We don't know, but if the combined experience of thousands of users is any indication, they will be. Better write today.

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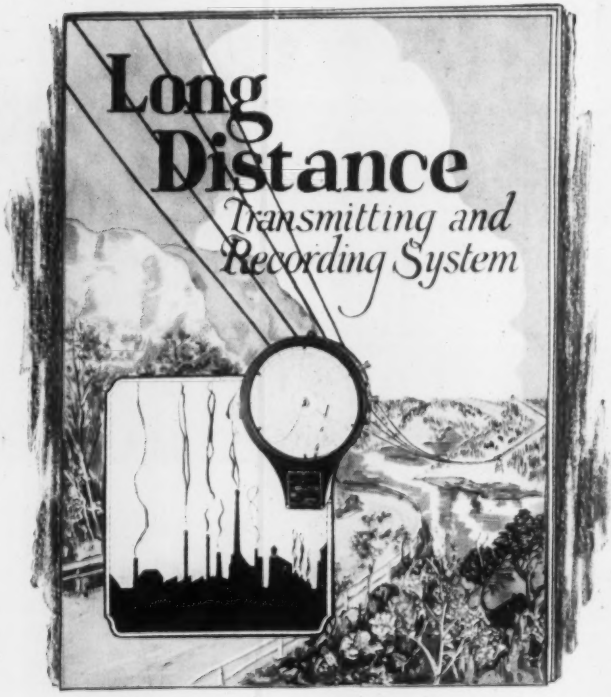
NEW Bristol's Catalog

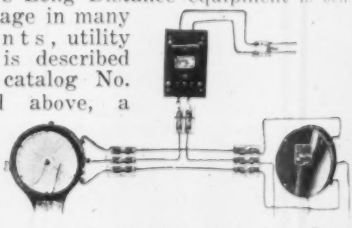
Gives Interesting Story of How Long Distance System Centralizes Operating Information at the Point of Control.



THE full benefit of using Bristol's Long Distance Transmitting and Recording System is better realized when one considers the instant contact it gives with operating conditions in all parts of the plant or system. For example, hydro-electric power stations and manufacturing plants which utilize water power to a greater or lesser degree, very often find it is vitally necessary to know the exact head of water being maintained in distant lakes, reservoirs, rivers, etc., or the action of head gates at out-of-the-way places not conveniently accessible by ordinary means.

In such instances a continual survey of existing conditions is provided by the Bristol's Long Distance System; the transmitting unit being installed at the source of liquid level, mechanical motion, pressure, temperature, etc., to be measured, and connected by means of three wires to a receiving recorder. This recorder can be mounted at any conveniently centralized point desired—at a distance of a few hundred feet away or even up to several miles—(successful installation has been made with transmitter and receiver eighteen miles apart). On the receiving instrument chart is recorded an exact duplication of conditions prevailing at the transmitter.

How Bristol's Long Distance equipment is being used to advantage in many industrial plants, utility systems, etc., is described fully in new catalog No. 1900, pictured above, a copy of which will be mailed to any interested person in your plant. Send us name and address.



Diagrammatic hook-up of Long Distance System for pressure. Left: Indicating Transmitter. Right: Recording Receiver.

The Most Extensive Line of Recording, Indicating and Controlling Equipment for the Industries, including:

Pressure and Vacuum Gauges; Liquid Level Gauges; Electrical Boiler Water Level Gauges; Recording Thermometers; Indicating and Recording Pyrometers; Recording Psychrometers; Recording Electrical Instruments (including Voltmeters, Milli-Voltmeters, Ammeters, Milli-Ammeters, Shunt Ammeters, Wattmeters, Frequency Meters); Mechanical Motion Recorders; Electrical Operation Recorders; Indicating and Recording Tachometers; Engine Counters; Revolution Counters; Averaging Instruments; Gaugeboard Clocks. Also equipment for automatically controlling Temperature, Pressure, Liquid Level, Liquid Flow, etc.; together with Motor Operated and Solenoid Controller Valves, and Control Panels.

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